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# Morris Arboretum Bulletin

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**Fig. 1. Yellowhorn**
*Xanthoceras sorbifolia* Bge.

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## THE ASSOCIATES OF THE MORRIS ARBORETUM

The ASSOCIATES, through whose interest and generosity this *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request. Communications should be addressed to The Morris Arboretum, Chestnut Hill, Philadelphia, Pennsylvania.

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## XANTHOCERAS — IN MEMORIAM

Almost a year ago a small ten foot tree was just preparing to flower. It was the Yellowhorn, *Xanthoceras sorbifolia,* illustrated on page 1, and one of the most prized and showiest possessions of the Morris Arboretum. The crop of flowers produced in May was good, although scarcely up to standard; but soon after flowering the leaves began to wither, branch by branch, then browned and shortly died. By mid-August nought remained but a memory of former beauty, companioned by a lifeless skeleton awaiting appropriate disposal.

The story is not a new one. Rather, it appears to be the normal mode of exit of a plant possessed of a complete and unvarying abhorrence of old age. This failing of *Xanthoceras* has been observed before both in America and Europe although it has not been recorded perhaps as often as it should; but then, Yellowhorn has always been a rare plant in spite of an introduction from China as early as 1868. W. J. Bean of Kew hints at a coral spot fungus as a possible cause of difficulty, but careful scrutiny of our own late lamented specimen revealed nothing to indicate any form of fungus-caused disease. Xanthoceras is a member of the Soapberry family and is thus a cousin of Koelreuteria, the Varnish Tree. Perhaps the weakness is born of this relationship since Koelreuteria, in age, seems also prone to a rather sudden, branch by branch departure. Koelreuteria, however, has considerably the longer life span and usually gives at least a year or two's warning of an approaching end.

The great beauty of Xanthoceras is seen in May in its quantities of pure white blooms—thickly clustered in abundant short spikes displayed against feathery foliage. Each petal unfolds with a yellow basal blotch which shortly changes to a bright purplish red, and each flower disk bears four horn-like projections from which the plant's name, Xanthoceras or Yellowhorn, has obviously been derived. The pinnate foliage remains a bright, glossy green until killed by frost. Fruits, which are borne quite frequently as the tree approaches maturity, are curious, round, green capsules the size of a small orange—each one hanging heavily from its slender branch, a swaying enticement to squirrels.

In Highland Park, Rochester, a lone, smallish Xanthoceras has the almost amusing habit of bursting into resplendent blossom on Lilac Sunday—that day when splendor by the acre draws milling throngs from far and near. Though the day belongs to the

(*Continued on page 10*)

# FERNS FOR A GARDEN *

Perhaps the first requisite of a garden is *order*. One would not think of planting tall-growing shrubs or trees in a rock garden or narrow border, any more than the reverse—putting nothing but rock plants or low-growing plants in a wide border. We adapt our plants to the space to be planted, and try to achieve a composition with definite order as to size, color and texture, as well as season of bloom.

In ferns, ample material for an ordered planting is at our disposal. We have forms which are tall, medium, or low-growing, of fine or leathery texture, evergreens, or those which are more perishable. By a little thought and care a fern garden or bed can give just as pleasing a composition, with its varying shades of green, as a garden of bright colors. Ferns, moreover, will grow in places where some plants will not—such as in a shady plot of ground or corner where they will do as well as in a small or large woodland, if one is fortunate in possessing the latter. Thus ferns have a strong place in the horticultural world even though they cannot be planted in the perennial border, which requires cultivation and sun, both of which ferns resent. They must not have their roots disturbed and do best with a covering of leaves or humus all through the year. Most varieties prefer a semi-shaded position, and an acid, friable, fairly moist soil. By "moist" soil is meant a well-drained soil, not dry, and yet not one that is constantly wet or marshy.

Ferns should be grouped in sufficient numbers of one species, and placed far enough apart that the beauty of the foliage and luxuriance of the growth can be seen to advantage, and not planted one of a kind, "hit-or-miss." The taller species may occasionally be used as specimens or as accents.

Ferns divide themselves into two classes. In the first are those with slender, branching rootlets at or just below the surface of the soil. These spread rapidly, putting up new fronds all through the growing season, and can be transplanted at any time. They form a dense mat and are more suited to large areas. Under this classification we have *Dennstaedtia punctilobula,* the Hayscented Fern, which prefers a dry, sunny, rocky location. Also of this class are *Dryopteris noveboracensis,* the New York Fern, which prefers a shady, dry place, and *Dryopteris thelypteris,* or Marsh Fern, preferring a moist ground; the last is more adaptable than the first one mentioned, but all three soon take possession of a large area.



Fig. 2. Cinnamon and Ostrich Fern in a Woodland Planting

The second class of ferns, those with thick rootstocks arising from a crown, bear only one set of fronds a season. In planting, the rootstock should be placed upright, with the crown just above the surface of the soil and the roots spread out in their natural position. Most of the ferns best adapted to garden usage come under this classification and a few are listed with their individual preferences:—

*Adiantum pedatum,* the Maiden Hair Fern, has a fine, light green leaf, dainty in texture, prefers shade, and, as it resents being moved, sometimes makes no growth for a year after transplanting.

The Aspleniums—*Asplenium platyneuron,* the Ebony Spleenwort, and *A. trichomanes,* the Maidenhair Spleenwort, are both low-growing (8-10 inches), suitable for an edging or rock garden and prefer a shady location and lime soil.

*Athyrium filix-femina,* or Ladyfern, adapts itself to any or every location in sun or shade, has a feathery frond eighteen or more inches long, and is one of the hardiest.

* Editor's Note. — The Morris Arboretum welcomes from one of its Associates this discussion of a plant group whose ornamental possibilities have been rather horticulturally slighted for too long a time. The authority for this article is of the best. Few persons have a better knowledge of the cultivation of hardy ferns than Mrs. Barnes who, at the Arboretum of the Barnes Foundation, has assembled one of the finest fern collections in America.

*Cystopteris bulbifera,* the Bulbous Bladder Fern, and *C. fragilis,* the Fragile Bladder Fern, are both low-growing (9-12 inches), but the latter dies down in August and leaves a bare place, unless the season is particularly propitious, when it produces a second crop of fronds. *C. bulbifera* not only lasts the entire season, but is not so particular as to location; and, as it reproduces by means of little bulblets on the underside of the rachis and pinnae, as well as by spores, it thrives and spreads profusely.



Fig. 3. *Dryopteris viridescens* is daintiest and most attractive of the Wood Ferns.

The Wood Ferns (*Dryopteris*)—all of easy culture—give us a wide choice. *Dryopteris clintoniana,* Clinton's Wood Fern, *D. cristata,* Crested Wood Fern, and *D. bootti,* a cross between the two, are all most attractive and about the same height (18-24 inches), while *D. filix-mas,* the Male Fern, is a little taller and narrower; and *D. goldiana,* Goldie's Wood Fern, is one of our handsomest tall varieties. *D. spinulosa,* Toothed Wood Fern, is again most desirable; and *D. marginalis,* Marginal or Leather Wood Fern, an evergreen with thick, blue green fronds, lends itself to grouping with ferns of a lighter green color and texture. *D. viridescens,* Glossy Wood Fern, is the daintiest and most attractive of all, but unfortunately not listed by many dealers.

*Onoclea sensibilis,* the Sensitive Fern, is of a rather coarse texture and frond, but will grow in poor soil, and, although it will spread rapidly, it fills a need. In winter, moreover, its dried sporophylls are not unattractive.

We have the Cliff Brakes—*Pellaea atropurpurea* and *P. glabella,* both of which, as their name implies, love to grow in cracks of cliffs, preferably limestone.

*Polypodium virginianum* is an evergreen, low-growing fern, delighting to grow on rocks or fallen logs in moist, shady places.

The best known, perhaps, of our evergreen ferns is *Polystichum acrostichoides*, the Christmas Fern, of a dark green color and a rather thick texture, which we see on steep north banks of our country roads—its preferred situation in a well-drained soil. *Polystichum braunii*, Braun's Holly Fern, is not quite evergreen; its heavy and rather hairy 18 to 20 inch fronds inevitably bend down in late Autumn. It prefers semi-shade and rather moist soil.

*Pteretis nodulosa*, the Ostrich Fern, which, with its 5 to 6 feet, is perhaps the tallest of our natives, is also one of the first to appear in the Spring. It dies down, however, in early August, leaving brown, bare stalks and also has the bad feature of spreading by adventitious buds on the rootstock.

The Woodsias—*Woodsia ilvensis* and *W. obtusa*—are both desirable low-growing, 8-10-inch ferns preferring cliffs as a natural habitat. But Woodsias are rather difficult to transplant, as also are the Woodwardias or Chain Ferns—*Woodwardia areolata* and *W. virginiana*.

Last, but not least, are the ever popular Osmundae—*Osmunda cinnamomea*, the Cinnamon Fern, *O. claytoniana*, the Interrupted Fern, and *O. regalis*, the Regal Fern, which three are all of easy culture, tall (18-24 inches) and grow in either sun or shade.

This, of course, is not a full list or description of all the many ferns now on the market (it is always best to buy from a nurseryman, rather than to rob our countryside), but I have tried to show that by choosing ferns of the correct height, texture and shade, a garden to give pleasure in all seasons of the year may be made. If bright color is deemed necessary, many of our native wildflowers will thrive under the same conditions as ferns and bring an added touch of interest to the picture.

Laura L. Barnes, *Director*,
Arboretum of the Barnes Foundation

## LECTURE TOURS AT THE ARBORETUM

As a result of the success of this feature last year, the following outdoor "discussion" tours have been scheduled for the 1942 season:

*May 9, 2:00 P. M.*

The Rock Wall

Leader: Archie Thornton, Rock plant Specialist of Poughkeepsie, N. Y.

As author of the Rock Garden Primer and a frequent contributor to horticultural literature, Mr. Thornton's name is familiar to all admirers of Rock and Alpine plants. On this date the rock wall at the Arboretum should be at its best. Discussion will center on wall plants as well as problems of maintenance. This lecture commences one half hour earlier than usual to permit those visitors who so desire to attend the University May Day pageant being held near the Germantown Gate at 3:00 P. M.

*May 30, 2:30 P. M.*

Eastern Asiatics in Eastern American Gardens

Leader: J. M. Fogg, Jr., Dean of the College and Associate Professor of Botany, University of Pennsylvania.

Dr. Fogg needs no introduction to a Philadelphia audience of either horticulturists or botanists. Although perhaps best known for his extensive studies of our native flora, Dr. Fogg has always had an especial interest in the numerous similarities between oriental and eastern American plants. He will have interesting facts about many of our finest ornamentals.

*June 6, 2:30 P. M.*

Establishment and Care of Lawns

Leader: Walter Lapp, Specialist in Lawn Care, Lansdale, Pa.

Mr. Lapp is well equipped to provide the kind of information most needed upon all kinds of lawn problems. There will be opportunity to visit Mr. Lapp's lawn test plots at the Arboretum, where various points regarding grass establishment, as well as fertilizer and weed treatments can best be demonstrated.

*September 26, 2:30 P. M.*

Poisonous Plants of Farm and Garden

Leader: D. Walter Steckbeck, Associate Professor of Botany, University of Pennsylvania.

Dr. Steckbeck has studied poisonous plants in various regions of the United States and is in charge of the work in Veterinary Botany at the University of Pennsylvania. Special attention will be given to poisonous and near poisonous plants of the Pennsylvania countryside with some reference to exotics and to plants yielding drugs.

*October 10, 2:30 P. M.*

MAN AND NUT TREES

Leader: J. RUSSELL SMITH, Swarthmore, Pa. Emeritus Professor of Economic Geography, Columbia University.

No one has contributed more to the field of Economic Geography than Dr. J. Russell Smith. He is president of the Association of American Geographers as well as author of various texts and articles in this field, including a book, *Tree Crops a Permanent Culture*. A world traveller, Dr. Smith has studied tree crops and their potentialities for permanent land improvement in many climates besides our own. He will have food for thought as well as first hand and practical information on nut varieties.

Anyone is welcome and is cordially invited to attend the above lectures, which occur at times when plants at the Arboretum are of maximum interest. There is no charge. Visitors are encouraged to bring along their problems.

All tours, unless otherwise stated, commence at 2:30 P. M. on Saturdays at the Administration Building and will last from one to two hours. In case of wet weather individual meetings will be automatically postponed one week. In this likelihood, confirmation can be secured by telephoning Chestnut Hill 5232.

## THE WALL GARDEN

Most popular spring feature at the Morris Arboretum is the six-foot rock wall which surrounds the rose garden upon three sides. As a reminder to those who may be planning a visit in the near future, the rock wall is now at just about its best and will continue in abundant color into early May.

Regular visitors may observe a few changes this year which we hope are also improvements. The wall has always been well clothed with flower



FIG. 4. The Arboretum Rock Wall at the height of the color season in early May.

but, with so many large clumps of candytuft, alyssum and moss pink, colors have not been too varied or of maximum interest. The flower season, moreover, has been short. Towards improving this situation a weeding and replacement process has been undertaken which has included the addition of some seventy new species and varieties of plants, selected upon a basis of their color, season of bloom and general suitability for wall usage. Alyssum, for instance, is now represented by four varieties rather than one, campanulas by at least seven, silenes by four and phlox and dianthus by numerous forms, in addition to very many genera of which there were formerly no representatives at all. Although these additions will be more conspicuous next year, a fair number can certainly be looked for this season.

As quickly as possible, a majority of plants of each variety is being provided with stainless steel identification labels, and commercial sources for the purchase of any plant in the collection will be available upon request to persons interested. It is hoped that this example of a rock wall which demonstrates the use of some of the best low-growing wall plants may thus amply justify its existence as an educational feature as well as one which, for many years, has been unquestionably decorative.

## TEN THOUSAND POUNDS OF BEEF

A strange topic from a botanical institution, it would seem; yet not so strange—in fact, appropriate and timely. The Arboretum area still awaiting development includes some fifty acres of good grassland. From April 29 to December 6, 1941, forty-five head of two-year-old beef cattle grazed this area continuously and, without any supplementary feeding, showed at the end of the season an aggregate gain in weight of about ten thousand pounds—five tons of quality beef on the hoof added to the food reservoir of the United Nations.

That growing farm animals consuming plants or plant products as feed convert a part of the ration into additional muscle, bone, fat, etc., ordinarily does not arouse our curiosity or wonderment because it is commonplace and universal. But when the question is asked, where do the plants get the foods which man and animals appropriate to build their bodies and furnish energy for their work, many of us will be perplexed and at a loss for a satisfying answer. Actually, what happened on the Arboretum acres involves the most basic and universal of physiological processes.

The nature of these processes can best be illustrated by a simple experiment. Most of us perform similar experiments in our garden and farm operations without perhaps being aware of it or fully appreciating the implications. Five grains of corn (maize) are planted in pure quartz sand and spaced to permit full development. They are kept supplied with water in which are dissolved small amounts, in some cases bare traces, of some six or eight mineral salts. Beyond this, merely a favorable growing temperature, sunlight, and air are provided. With crows, cutworms, and squirrels exercising proper restraint, the grains germinate and seedlings emerge, growing into plants which flower and in turn bear seeds. Assuming that each plant bears two ears, the yield of grain will be sufficient for a generous family meal of nutritious corn bread. In addition, there are the dry leaves, shucks, and tassels as palatable stock feed, still leaving substantial amounts of organic matter in the form of stalks and roots. And we started with five grains of corn!

Before attempting to interpret the experiment, it may be instructive to ponder the probable performance of one of the steers subjected to the same experiment. In attempting to subsist and grow on the diet of water and a few mineral salts, while basking in the warm sunshine and breathing pure country air, the steer will, we fear, have the experience of the Missouri mule whose master attempted to teach him how to get along without feed. Just as he had about learned it he up and died. Why this amazing difference between animals and green plants? The answer involves one of the most fundamental processes in all nature, and leads us back to a closer examination of our corn experiment.

Obviously the corn plants did not have available in their environment any of the substances which we commonly think of as foods—carbohydrates, fats, proteins, etc. (the small amounts of these substances present in the seeds planted were soon used up in the early stages of development). And yet the harvest of corn grains contains these in abundance, as do in varying degree the other parts of the plants. Where did the plants get them?

The answer is, they made them—out of the simple inorganic materials available to them. It is precisely this that animals are unable to do and that makes them all, including man, directly or indirectly dependent upon plants. Granted that some animals live entirely on others and these in turn on others, sooner or later in this chain we come invariably to a link where the dependence is on plants. Green plants are in fact a sine qua non of animal existence.

Chemical analysis reveals that plants are composed of a great array of organic compounds, in which carbohydrates, and to a lesser extent proteins and fats, usually predominate. All these substances contain the element carbon (so common in coal) in combined form. Besides carbon some ten or a dozen other chemical elements are represented in appreciable amounts. But for our present purpose it will be well to keep attention fixed on carbon. Where does the plant get this indispensable component, which accounts for roughly fifty per cent of the dry weight of plants?

For a time it was believed that the " humus " of the soil was the source. This possibility is excluded in our simple experiment because the usual soil was replaced by pure quartz sand (composed only of silicon and oxygen). Rapid advances in chemistry beginning in the latter half of the eighteenth century made it possible to prove at the turn of that century that the *air,* not the soil, is the source of the carbon. This at first seemed incredible for in ordinary air the only carbon is that in the gas carbon dioxide, which makes up but three-hundredths of one per cent of the air by volume. But a firmly established fact it is. We come then to the astounding fact that the colossal amounts of carbon which green plants build into their bodies are extracted from the minute quantities of carbon dioxide in the atmosphere, a substance which, together with water, represents the chief waste product in animal respiration and in fuel combustion.

The green plant thus covers its carbon requirements from the very substance which the animal casts out as completely oxidized (having had all the available energy extracted) and which it is unable to utilize as a carbon source for its nutritional requirements. In this fact we discern the bold outlines of a profound difference between animals and green plants and the reason why the former could not exist without the latter. What is responsible for this fundamental distinction between the corn plants, which get along with only carbon dioxide as a source of carbon, and the steers, which require as a source of carbon such energy-loaded and highly synthesized compounds as the carbohydrates, proteins, fats, etc., acquired in munching the Arboretum grass?

The answer is *photosynthesis.* Since this is probably the most fundamental of all biological processes, it merits examination. Its general nature is disclosed by its name—synthesis implemented by light.

It is common knowledge that the bodies of plants, like those of animals, are subdivided into microscopic coordinated and interdependent units term " cells." The living active stuff—protoplasm —in these cells contains numerous microscopic disc-shaped protoplasmic bodies termed *plastids.* When these plastid-containing cells are exposed to light, a complex organic green pigment—*chlorophyll*—is produced, rendering the plastids bright green. It is this process which is responsible for the prompt greening of the emergent portion of seedlings while that below ground remains blanched. It is seen again in the rapid greening of dark-developed sprouts of seeds, bulbs, tubers, etc., when brought into the light. We come thus to the broad generalization that it is these myriads of chlorophyll-containing plastids (*chloroplasts*) imbedded in the protoplasm that render leaves and other plant parts green.

In the absence of definite knowledge, man was prone to view this prevailing dress of green as donned for his special delight—restful and beautiful to behold, which assuredly it is. Alas, man's egocentric proclivities here, as often in other matters, led him to overlook what the green might mean to its possessors. As is now known, its significance is fundamental. Though our readiness with anthropomorphic interpretations has received a healthy jolt, understanding and something akin to respect has been added to our undiminished love of and delight in the green of plants.

These chloroplasts turn out to be the myriad amazing laboratories in which, and in which alone, the plant brings the carbon of atmospheric carbon dioxide back into the organic cycle by means of a unique synthesis. More specifically, in these green plastids, with sunlight as the source of energy, the components of carbon dioxide and water are chemically rearranged and combined in such a way as to produce, probably after several intermediate steps, a soluble sugar (carbohy-

drate); and in the process oxygen is released. The precise course of this synthesis is not known. Certain it is, however, that within the chloroplasts when exposed to sufficient light, carbohydrates are easily detectable within a short time after illumination starts. And the amount increases with time, so that during a sunny summer day the plastids become literally gorged with carbohydrate.

Too much emphasis can scarcely be placed on the cosmic significance of the phenomenon here sketchily described—carbon dioxide and water synthesized into carbohydrate in the plastids, with the indispensable participation in some way of the chlorophyll and with sunlight furnishing the energy necessary to do the work. In a certain sense carbon dioxide and water are the very "foods" the plant uses in the process. And to this extent, since oxygen is *released* as a waste product in this synthesis, photosynthesis is the exact reverse of those metabolic processes in animals in which sugars, by the *addition* of oxygen, are completely oxidized ("burned") to carbon dioxide and water, yielding up *all* their stored chemical energy for the animals' use.

It was remarked above that sunlight furnishes the energy to do the work in photosynthesis. A sugar like glucose, which is a common ultimate product of photosynthesis, gives no external evidence of being charged with energy. But if it is ignited it burns, liberating intense heat (a pound of glucose completely burned to carbon dioxide and water will raise the temperature of four and one half gallons of water from the freezing to the boiling point). This heat is obviously an *active* perceptible form of energy that can be made to do work, e. g., drive a steam engine. But where does the heat come from when glucose is burned? The answer is, from the *latent* energy in the glucose, a form of energy termed chemical energy and which obviously is not perceptible in the sugar as such.

In pursuing this energy trail, we must pose one more question: Where does the sugar produced in photosynthesis from carbon dioxide and water get the energy which is stored in its molecules as chemical energy? Here the answer is *sunlight*. Active light energy is thus converted into an equivalent amount of latent chemical energy locked up in the glucose produced as a result of photosynthesis. Light, then, is the ultimate source of all energy in living organisms. And since coal and petroleum are the unoxidized carbon remains of once living organisms, these enormous stores of energy also derive from sunlight converted into latent chemical energy in past geological ages through the instrumentality of photosynthesis.

Against the background of this transcendent importance of sunlight and photosynthesis in the maintenance of all life, we return to our Arboretum acres. Between April 26 and December 5, 1941, the fifty grassy acres received a total amount of light energy equivalent to the heat energy obtained by the complete combustion of 24,396 tons of high quality anthracite coal, or 488 tons per acre.[1] If even most of this lavish supply of energy were used in photosynthesis and locked up as chemical energy in the organic substances produced, we would indeed have a bonanza of available energy and organic materials. Were this the case it would allay the growing concern of mankind as the exhaustion of the supposedly endless stores of energy in coal and petroleum looms as a specter on the horizon. Though intensive use of coal covers only somewhat more than a century and that of oil less than half that period, the end is in sight, whether the calculations of experts be gloomy or rosy. Literally, the colossal reservoirs of energy in the form of unoxidized remains of carbon compounds built up over the geological eons, directly or indirectly through photosynthesis, are being squandered in a gigantic spree—the industrial age—, and never before so recklessly as today. And the inevitable ensuing migraine of this brief, geologically speaking, exhilarating moment is already palpably evident.

Alas, at best photosynthesis utilizes but a small fraction of the light energy available (or shall we say alas, for man's use of unlimited accessory physical power has not been too reassuring to date). No measurements have been made on the Arboretum area. Such data as are available for certain crops and types of vegetation in other regions and latitudes make it doubtful that the grass on the fifty acres used in photosynthesis over one per cent of the available energy. Much of the

[1] Solar radiation records for the Philadelphia area are not available; but for Washington, D. C., continuous observations have been made since 1914, and for New York City since 1924. Since total radiation varies with latitude, and since Philadelphia latitudinally is not far from midway between these two observation points, the above calculations represent the mean of the Washington and New York data (taken from HAND, IRVING F. Review of United States Weather Bureau solar radiation investigations. *Monthly Weather Review*, Vol. 65: pages 415-441. 1937).

light is reflected into space from the plants and the soil; other substantial quantities not intercepted by the plants are absorbed by the soil; and in other ways the efficiency of the photosynthetic utilization of the available light is limited.

But inefficient as it may appear to be, photosynthesis is still the only effective process for employing light in the synthesis of organic life-sustaining products and trapping and storing light energy as latent chemical energy in the substances synthesized. Aside from minor human devices designed to utilize light energy, such as heating water or propelling "sun motors," science and technology have not to date succeeded in effectively harnessing light energy. Perhaps this is because they have not as yet wrested from the tiny living chloroplast its full cosmic secret.

This is not the place to attempt to trace in detail the fate of the grass munched by the steers. Suffice it to recall that much of the organic material (food) is used up to furnish energy to maintain body temperature and activity; indigestible or unused portions are lost as wastes; etc. Thus, only a minor fraction of the latent chemical energy in the grass finally turns up in the substance of added muscle, fat, etc., i. e., as gain in weight. And, though impressive, the 10,000 pounds of beef produced represent, in terms of latent energy content, not only an extremely small fraction of the light energy available on the fifty acres, but also only a minor part of that bound by photosynthesis in the grass consumed.

We may call this inefficient if we like; but it is the economy nature has evolved, based on the utilization of light energy by green plants through photosynthesis. And man to date has devised no practical substitute for it. And so it is that green areas,[1] whether occupied by crop plants, grass, or forest, are the sole ultimate source of food, whether plant or animal, and of life-sustaining energy. The Arboretum acres are enlisted for the duration.

J. R. Schramm

[1] In the oceans and fresh waters, with their teeming life yielding much food for man and animals, the principle is identical. It would take us too far to explore this fascinating field here.

## Xanthoceras — In Memoriam

(*Continued from page 2*)

lilac, yet it is in front of Xanthoceras more than any other one plant that the family line keeps forming and the Kodaks click. It's away in a corner; it's small, but it steals the show.

Propagation of Xanthoceras is usually by seeds or root cuttings. Seeds, stratified or held cool over winter, will germinate quite readily in the spring. The resultant seedlings, however, are peculiar in that 30 or 40 percent are frequently albinos which attain a height of an inch or two but, totally lacking in chlorophyll, are able to make no further growth when the food contained in the rather large seed has become exhausted.

The ability of roots to produce new individuals is now being well demonstrated at the Arboretum. The specimen, prior to demise, never showed much tendency to sucker. Before fall however, last year, a fair scattering of young shoots appeared several feet from the original trunk—obviously from roots which had remained alive even though the top had long since ceased to function. It is to be hoped that these suckers may provide for us the start of another generation of this, one of the loveliest of all small trees.

Henry T. Skinner

## NOTES FROM THE LABORATORY

### Locust Leaf-Miner on Pagoda-Tree

Last year (1941) during the extremely heavy infestation of black locust trees with the locust leaf-miner, *Chalepus dorsalis,* the same insect was also found to be infesting *Sophora japonica,* the Japanese Pagoda-Tree. Mining of about five to ten per cent of the leaves was noted in late June and emergence of the adult beetles from July second to the tenth.

While control is possible by an arsenate of lead spray in April, it is not considered a necessary precaution in this instance in view of the light infestation of the newly observed host in a summer which saw black locust trees practically one hundred per cent invaded.

This report is made not because of the importance of the outbreak but rather because it is the first time that this insect-host relationship has come to our attention.

Spencer H. Davis, Jr.

## An Effective Control for Leaf Blight of English Hawthorn

A pink-flowered English hawthorn, *Crataegus oxycantha rosea-plena*, growing just inside the main entrance to the Morris Arboretum, has been heavily attacked by the leaf blight disease (*Entomosporium thcumenii*) for a number of years. This organism has caused an annual defoliation of all of this species of Crataegus in the vicinity, the trees becoming leafless before the first of September.

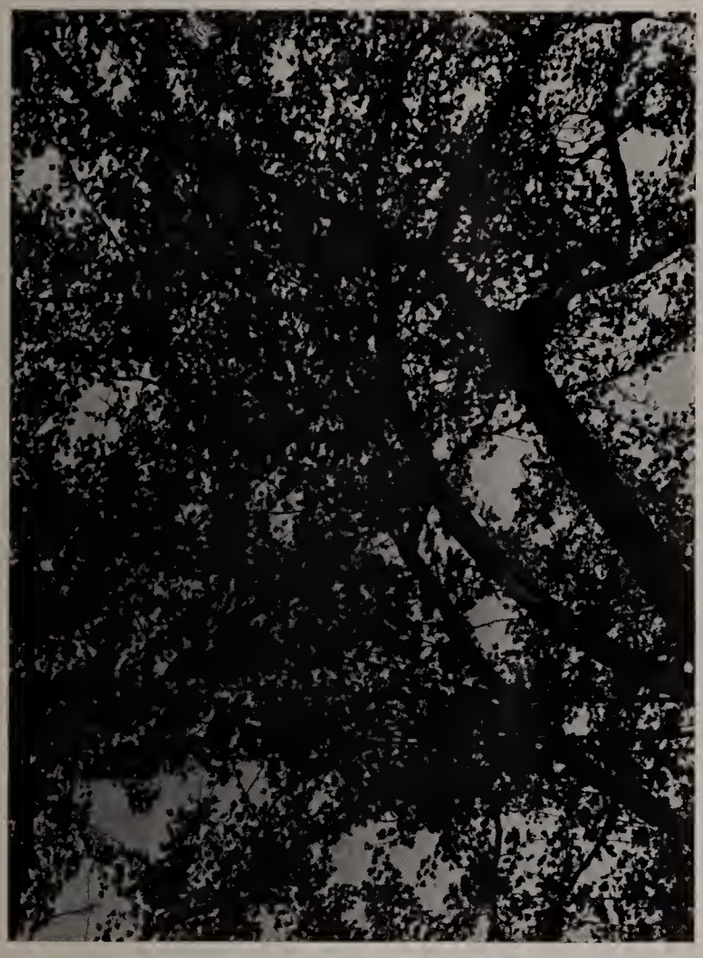


Fig. 5. Looking up through foliage of sprayed tree.

Last summer a spray schedule was followed which consisted of Bordeaux 4-4-50 at bud break (April 16) and again on April 22 and 30. On the first of October the tree was still bearing good foliage, although somewhat leaf-spotted, in contrast to the almost leafless trees of this species in the neighborhood of the Arboretum. (figs. 5 and 6).

The photographs, taken October the first, show the foliage carried by the sprayed tree, and the condition of an unsprayed tree on a nearby estate. On the unsprayed trees the small covering of leaves is not of the original spring break but those of a second crop which appeared later in the summer following the complete defoliation by mid-August. Concurrent with the scanty new crop of leaves were also a few flower-clusters, an entirely abnormal condition resulting from the extreme defoliation.

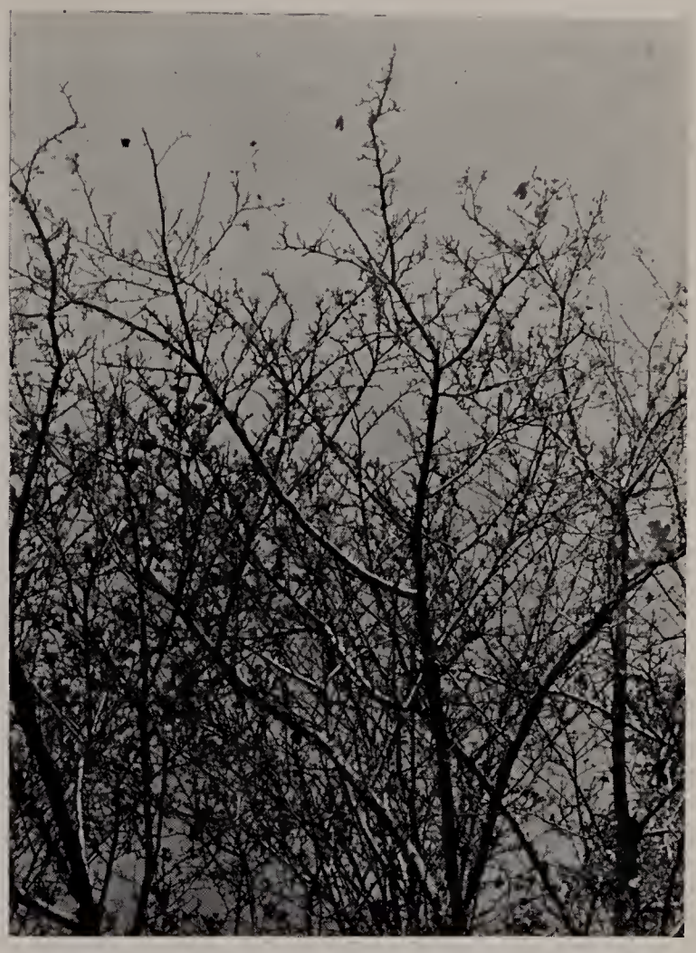


Fig. 6. Looking up through foliage of unsprayed trees.

Spencer H. Davis, Jr.

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# ARBORETUM BULLETIN

AUGUST, 1942

Volume 4. Number 2



**Fig. 7. Raisin Tree**
*Hovenia dulcis* Thunb.

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# *THE RAISIN TREE*

Illustrated on page 13 are flowers of the Japanese Raisin Tree, *Hovenia dulcis*, an infrequently described ornamental which is unusual and apparently still a rarity, even in botanical collections.

Although the Raisin Tree was introduced as early as 1820 from Japan it is in reality a native of central China which, through cultivation, was early carried throughout China and India as well as to Japan and Korea. The name Hovenia is in honor of David ten Hoven, 1724-87, senator of Amsterdam.

*Hovenia dulcis* is akin to Ceanothus and the Buckthorns, being a member of the family Rhamnaceae. It is grown principally for its handsome, glossy, green, broad, and long-petioled leaves. The flowers are yellowish green and, though small, are produced abundantly in axillary and terminal clusters in late June. They have a peculiar, pungent odor which seems attractive to many kinds of insects. Fruits, which are about the size of a pea, are borne partially embedded in fleshy and swollen flower stalks. These contorted

(*Continued on page 20*)



FIG. 8. *Hovenia dulcis* at Morris Arboretum

# EASTERN ASIATIC PLANTS IN EASTERN AMERICAN GARDENS[1]

JOHN M. FOGG, JR.

Even the most casual visitor to the Morris Arboretum cannot fail to be impressed by the overwhelming preponderance of trees and shrubs growing there which are native to southeastern Asia. Although he may not be able to recognize or identify these species on sight, he need only glance at the labels to learn that many plants are indigenous to China, Manchuria, Korea, Japan, or some other portion of the Orient. Indeed, so large is the number of these exotics that at times it necessitates a conscious effort to realize that one is still in eastern North America.

Scattered throughout the broad acreage of the Arboretum are splendid specimens of such plants as the Ginkgo or Maidenhair Tree (*Ginkgo biloba*), Golden Larch (*Pseudolarix amabilis*), Umbrella Pine (*Sciadopitys verticillata*), Chinese Elm (*Ulmus parvifolia*), Siberian Elm (*U. pumila*), Katsura Tree (*Cercidiphyllum japonicum*), False Spiraea (*Sorbaria sorbifolia*), Pearl Bush (*Exochorda racemosa*), Pagoda Tree *Sophora japonica*), "Japanese Quince" (*Chaenomeles lagenaria*), Hardy Orange (*Poncirus trifoliata*), Cork Trees (*Phellodendron* spp.), Cedrela (*Cedrela sinensis*), Varnish Tree (*Koelreuteria paniculata*), Raisin Tree (*Hovenia dulcis*) and Beauty Bush (*Kolkwitzia amabilis*). All of these are native to southeastern Asia. In addition to the above, the visitor will observe that certain genera with which he may be familiar in our native flora are represented by large numbers of oriental species. This is particularly true of Magnolia, Berberis, Hamamelis, Benzoin, Hydrangea, Philadelphus, Spiraea, Malus, Prunus, Wisteria, Gordonia, Stewartia, Cornus, Rhododendron, Callicarpa, Lonicera and Viburnum. All of these are genera which have their centers of origin in the Middle Atlantic States and in southeastern Asia, with usually an appreciably larger number of species native to the latter area. Certain other genera such as Caragana, Enkianthus and Weigela occur solely in Asia and are known to us only through cultivation.

The situation just described is not in any sense peculiar to the Morris Arboretum, but may be duplicated in practically every other large collection of living trees and shrubs in the eastern United States. In fact, many collections of woody plants in this part of the world are richer in oriental species than in those native to eastern North America.

To understand why it is that the flora from a region ten thousand miles distant should be so well represented in our gardens, parks and arboreta, we must turn to the evidence furnished us by the geologist and the paleobotanist, or student of fossil plants. It is necessary to project our minds backward millions of years into earth history and inquire briefly into the long sequence of events which has produced the existing vegetational pattern on the surface of the earth. Since the story is a lengthy and involved one, it will be well to confine ourselves to that portion of it which concerns the northern hemisphere.

Of all groups of living plants the most important and most numerous are the seed plants, with something like one hundred and fifty thousand species, a number far in excess of the combined total of all other types of plants. The seed plants comprise two subdivisions: the Gymnosperms and the Angiosperms. To the Gymnosperms, or naked-seed plants, belong the Cycad, the Ginkgo and the Conifers—including such familiar "needle-bearing" softwood trees as Yew, Pine, Larch, Cedar, Fir, Hemlock, Cypress and Juniper. In the Angiosperms or true flowering plants, the seeds are enclosed in and protected by the matured ovary or fruit. To this subdivision, which is by far the larger, belong not only all of the deciduous, hardwood, broad-leaved trees, but all of our familiar shrubs and herbaceous plants, including grasses, sedges and rushes.

Of these two subdivisions the former is much more primitive and more ancient. Indeed, the Gymnosperm line extends back some two hundred million years to the end of that great era known to the geologists as Paleozoic. Here, during the period when much of our coal was being formed, there flourished the ancestors of our present-day Cycad, Ginkgo, Pine, Fir, Larch, Spruce, Juniper, Cypress, as well as many other Gymnosperms which have long since become extinct. Further-

[1] Condensation of a talk delivered in the series of outdoor tours at the Arboretum on Saturday, May 30, 1942.

more, there is abundant evidence to indicate that for long stretches of millions of years these ancient Gymnosperms were widely distributed over the earth's surface, growing in regions north of the Arctic Circle where today it would be impossible for them to exist. The explanation of this broad distribution lies in the fact that the climate toward the poles was at one time much milder than it is today.

The close of Paleozoic was marked by the uplift of the Appalachian Mountains, which at the time of their elevation were considerably higher than they are today. Many of the early Gymnosperms became extinct at this time and we witness here the first great disruption in the continuity of our modern floras.

The Angiosperms, or flowering plants, are of much more recent origin than the Gymnosperms. Their beginnings may be traced back with certainty to the period known to geologists as Cretaceous. By the end of this period, which terminated the great Age of Reptiles, the Angiosperm flora had become well established. Late Cretaceous deposits contain fossils of many of our modern forest types such as Willows, Poplars, Oaks, Chestnuts, Beeches, Buttonwoods, Sassafras, Magnolia, Persimmon, and many others. Since this period came to its close about sixty million years ago, it is clear that, although the Angiosperms are considerably younger than the Gymnosperms, many of our present-day genera still possess a venerable ancestry.

As was true in the case of the older Gymnosperms, or conifers, an ever increasing body of evidence demonstrates that these early flowering plants enjoyed a much wider distribution than is the case today. Such trees as Magnolia, Sassafras, Persimmon and Tupelo not only occurred in every major land mass of the northern hemisphere but even grew in such now inhospitable regions as Alaska, Greenland, Iceland, Spitzbergen, Novaya Zemlya, Franz Joseph Land and northeastern Siberia. This is again indicative of the fact that during much of Tertiary time (the period of about sixty million years which followed the Cretaceous) the world climate was much more equitable than it is now. Indeed, the present distribution into climatic zones, such as Arctic, Temperate and Torrid, must be regarded as one which is very untypical of the long history of the earth. The normal situation, and one which has persisted throughout the great body of geological time, is for temperatures to be warmer near the poles and cooler near the equator than is true now. The reasons for this are rather complex but may be stated briefly as being concerned with mountain uplift and land barriers. There are at present many high mountain ridges in existence, but this has not always been so; and during long periods of millions of years each, when the average elevation of the continents was nearer sea level than it is now, there was much freer circulation of both air and water currents, resulting in the more uniform world climate mentioned above. This uniformity of climate was naturally reflected in a more even distribution of plants and animals.

In contrast to the wide-spread distribution of plants which characterized most of Tertiary time, we find today that the same genera which were formerly ubiquitous are restricted to smaller areas or centers of distribution which may be separated from each other by several thousand miles. Obviously something has happened to disrupt the former broad ranges of these genera, and it becomes pertinent to ask what these factors were. When we inquire what influences have been at work which would tend to alter the vegetation during the last sixty million years, we find that they fall into four categories: submergence, mountain uplift, volcanic activity, glaciation. Let us examine each of these briefly.

As has been said before, the Angiosperms, or true flowering plants, first became dominant toward the close of Cretaceous time, at which period they seem to have been widely distributed over the surface of the earth. Now Cretaceous time, among other things, was a period of lowering, or down-warping, of the continents, resulting in flooding by the oceans and the creation of great inland seas. Such a sea extended from the Gulf of Mexico to the Arctic Ocean, separating North America into two great halves or islands. As may well be imagined, this inundation completely destroyed the terrestrial vegetation which had formerly occupied the area now flooded. At the same time similar inundations were affecting parts of other continents, notably Europe. The Mediterranean occupied an area probably three times as great as that of its present basin and much of the original Angiosperm flora of Europe was destroyed as a result. Even after the Cretaceous seas were " tipped off " by the uplift of the con-

tinent much of the Atlantic Coastal Plain and the present Gulf States remained under the waters of the Atlantic Ocean and continued to be submerged for many millions of years during Tertiary.

In all cases where an area has been submerged for a long interval and is subsequently exposed, its surface is composed of sediments which were deposited while it was under water. These soils are therefore of more recent origin than the underlying formations, and the region is then repopulated either by newly evolving forms of plant life or by the more aggressive and pioneering species from some nearby survival area. Hence, we conclude that the flora of Mediterranean Europe or of the Atlantic coastal plain or of our own midwestern area is more modern than that of regions which were not submerged.

Mountain uplift in itself probably exerts no serious influence upon plant life. This results from the fact that mountain building takes place very slowly and may require thousands, if not hundreds of thousands, of years for its completion. We might be living on the future crest of a newly forming mountain today and be completely unaware of it. What is important in mountain uplift is the subsequent change of climate which it induces. When, for example, a mountain axis, such as that of the Rocky Mountains, is at right angles to the direction of the prevailing westerly winds, a marked difference in temperature and rainfall relations ensues. Moisture-laden winds blowing in from the Pacific strike against such a ridge and deposit their rainfall. This results in the region east of the mountains becoming arid. Therefore, an area which formerly possessed a rather uniform climate may, following uplift, be differentiated into rain forest on one side and desert on the other. This is but a crude and somewhat over-simplified example of the type of influence which has altered the vegetation in many parts of the world as a result of mountain building.

It is highly significant that since the beginning of Tertiary time, some sixty million years ago, eastern North America has not undergone any pronounced uplift of the type which much earlier produced the Appalachian Mountains. In marked contrast to this is the situation in western North America, where, since the advent of the Angiosperms, there have been two major episodes of uplift. The first of these, occurring as the Laramide Uplift at the end of Cretaceous, produced the Rocky Mountain axis. Then, millions of years later, toward the close of Tertiary, occurred the Cascade Uplift, which elevated the Pacific Coast ranges, including the Sierra Nevadas. These last-named ridges are therefore the youngest of all mountains on this continent.

Thus it will be seen that the climate of central and western North America has been profoundly altered at least twice, as a result of uplift, with corresponding effects on the distribution of plant-life.

Had we time to consider the events which took place in other continents we would see again the profound influences of uplift in changing the previous climate. One example that may be mentioned is the Alps of southern Europe which are mountains of a very recent origin, the uplift of which exerted profound effects upon the plant life of that continent. It is also worth noting in passing that whereas the mountain systems of North America have in general a north to south trend, the prominent ranges of western and central Europe extend in an east to west direction.

The only other considerable area in the northern hemisphere which has not undergone uplift since the appearance of our modern flora is southeastern Asia. Here, although there are mountains they are of much more ancient origin, corresponding to the Appalachians in age and in the degree to which they have been lowered, rounded and dissected by erosion.

When we say that volcanic activity has influenced the distribution of plant-life we do not refer entirely to the more spectacular type illustrated by such volcanoes as Vesuvius or Etna, although many such occurred in previous times. We mean rather the slow outpouring of hot volcanic rock which has so often occurred in geologic history when cracks or fissures have developed in the earth's crust. For instance, during Tertiary time many thousands of square miles in western North America were covered by the outpourings of such material, resulting in total destruction of all terrestrial life. Some of these deposits were very thick and may be readily seen in the western states today (notably Washington, Oregon, Idaho, Nevada, New Mexico and Arizona) where they have weathered to form dark colored soils which are often very fertile in those areas where rainfall is sufficient. Similar out-

pourings in other continents exerted corresponding influence upon living things.

Of all of the factors which have tended to wipe out existing vegetation the most recent, and in a sense the most spectacular, has been the formation of great continental ice sheets or glaciers. This is not to say that glaciation has been confined only to recent geological times. On the contrary, there is evidence that the close of each major geologic interval was attended by glaciation. However, most of these earlier accumulations of ice took place before the date of evolution of our modern flora and it is still true that for us the most significant of all the great glacial epochs is that which was inaugurated about a million years ago. This most recent manifestation falls within the period known to the geologist as Pleistocene.

Originating in three, or possibly four, centers in northern North America, the ice moved southward over all of Canada, New England, New York and in our area reached its southern limit in extreme northeastern Pennsylvania. It also covered the northern half of Ohio and Indiana and pushed southward near the junction of the Missouri and Mississippi Rivers. Obviously, this tremendous field of ice acted effectively to destroy the vegetation not only in the area upon which it lay but probably also for some miles beyond the actual ice front. Evidence indicates that Pleistocene glaciation was not a single phenomenon but that there were several advances of the ice separated by warmer interglacial periods during which the vegetation was able to regain much of the area from which it had been excluded. In Europe, glaciation centered mostly about Scandinavia and the Baltic area and was not so extensive as in North America. Much of eastern Europe was unglaciated and strangely enough Asia was visited only by local glaciers. This resulted from the fact that one of the factors necessary for continental glaciation is abundant precipitation and much of Siberia was, and is today, rather arid. Even portions of Alaska were not covered by ice fields nor were the islands of the Arctic Archipelago. Again, this was due to lack of precipitation.

The last advance of the Pleistocene ice, known to students as the "Wisconsin Phase," apparently began to disappear about thirty thousand years ago. Shrinking back toward its centers of origin, the ice slowly left uncovered New York, New England and southern Canada. At the same time it was shrinking southward from the Arctic Ocean and exposing vast areas in Labrador and northern Canada. The vegetation of most of Canada and all of New England has therefore had to reestablish itself only within these last few thousand years. Man himself probably did not reach the North American continent by way of Bering Straits until some ten thousand years ago, at which time the Wisconsin ice had melted sufficiently to permit his migrations.

Looking backward now over this sequence of events we see that most large areas of the northern hemisphere have been subjected to at least one, if not more, of these destroying influences. Indeed, there are only two major regions which have in any sense escaped and have succeeded in retaining the vegetation with which they started at the beginning of Tertiary time. Those are the Appalachian Plateau (and the smaller Ozark Plateau), south of the southernmost line of glacial advance, and southeastern Asia. All other portions of the northern hemisphere have either been submerged by continental seas or have had their climate profoundly altered as a result of mountain-forming, or have suffered from the encroachments of ice sheets of great thickness.

Therefore, it is no mere coincidence that there should be such a strong resemblance between the flora of the Appalachian Plateau and southeastern Asia. The similarity in the trees, shrubs and herbs of these two regions is not merely a chance occurrence but results from the long sequence of events just indicated. The story in these two regions is one of continuity, survival and persistence contrasted with the discontinuity, destruction and revegetation which characterize most other parts of the northern temperate zone.

In the Middle Atlantic States and in China we have reason to believe that many of the plants alive today are the offspring of a very ancient line extending far back into geologic time. Such a genus as Liriodendron, for instance, is known to have occurred in all parts of North America as far north as Alaska, in western Europe as well as across Siberia. This was during Tertiary time. Today Liriodendron is represented by a single species in the Middle Atlantic States, *L. tulipifera*, the Tulip Tree, and by a closely related species in China. In all other areas it has become extinct

due to one or more of the destructive factors described earlier. Indeed, so similar are the American and Chinese Tulip Trees that it requires considerable discrimination to separate them. Many botanists consider them one and the same species. It is rather stirring to realize that the plants of this species which tower over our heads in the forests today have descended directly from ancestors which were once world-wide but which have survived only in those two parts of the world where conditions have been uniform.

It is actually true that the botanist familiar with the plants of the Appalachian Plateau will feel more at home when visiting southeastern Asia than in any other portions of the world. There he will find not only many of the common forest trees such as Tulip Tree, Magnolia, Sassafras, Persimmon and others, but such shrubby forms as Witchhazels, Dogwoods, Rhododendrons, Barberries and scores of others.

Even the herbaceous flora, which is probably less ancient than the woody one, displays many affinities. For example, the Skunk Cabbage, which was doubtless wide-spread during Tertiary, is today confined to the woodland swamps of Appalachian America and southeastern Asia. In fact, the Chinese species is indistinguishable from our own. To some it may seem that seeds of this plant might, in recent times, have been transported from one area to the other, but there is no evidence to indicate that this is so. Surely the heavy seeds of this species could not be borne by winds, birds, water currents or any other agencies which usually serve to disseminate plants. Even if this were possible we should expect to find colonies of Skunk Cabbage in western America or some other part of the world where it might have established itself. The actual explanation, as in the case of the trees, is that Skunk Cabbage has persisted in these two widely remote regions while undergoing extermination in other areas which it once occupied. Many other herbaceous genera (such as Hydrastis, Trautvetteria, Diphylleia, Jeffersonia, Podophyllum, Panax and Phryma) have had a comparable history and are today found only in eastern Asia and eastern America.

It should now be apparent that because of the similarity in geologic history southeastern Asia and Appalachian America possess similar soils and comparable climates. This will explain why oriental plants are so highly successful when transported to our region. The reverse is equally true. It is a conspicuous fact that China is still the most productive source of introductions for eastern American use. The explorations of Fortune, Wilson, Rock and many another plant hunter have added hundreds of Chinese species to our parks and gardens, and there are doubtless many more awaiting discovery and introduction.

It must not be inferred from the above discussion that plants from other parts of the world cannot be made to grow here. Let us briefly consider two other major areas. As has been pointed out, the story of events in Europe is one of wholesale destruction and subsequent replacement rather than survival. That part of the original flowering-plant flora of Europe which was not disturbed by inundation suffered heavily from the twin influences of mountain building and climatic change. Furthermore, glaciation in Europe, although less extensive than in North America, took its large toll of the vegetation. This was due to the fact that the ice advanced from the north and that the mountain ranges, trending, as has been said, from east to west, served as a barrier to prevent plants from migrating before the advancing ice front. This was very different from the situation existing in eastern North America where plants had the entire Appalachian Plateau in which to take refuge as glaciation moved southward.

Despite these destructive factors which so seriously modified the primal vegetation of Europe, certain restricted areas managed to escape and succeeded in retaining much of their early flora. This is particularly true of portions of the Caucasus, of the Balkan peninsula and a few still smaller survival areas in extreme southwestern Europe. As would be expected, the plants of these regions possess an antiquity comparable to our Appalachian flora and, by the same token, may be successfully grown in our portion of the world. Many other European species, however, may be grown only with difficulty, if at all, in the Middle Atlantic States. They come from a region where the soils are of modern origin and where the climate differs from our own. Many of them may be cultivated on the more youthful soils of our Pacific states, where, too, they enjoy a climate (mild winters and cool summers) more like that of Europe than is our Eastern one. Climate, it must always be remembered, is as much a product of geological events as are soils.

That portion of North America lying west of the hundredth meridian has undergone a geologic history similar to that of much of Europe. As already shown, it has suffered from submergence, uplift, climatic shift, volcanic outflow and, the northern portion of it, from glaciation, so that we find there modern and highly specialized plant families (such as the Mallows, the Spurges, the Mints, the Figworts and the Composites) adapted to soils of comparatively recent origin. As would be expected, we encounter in general the same difficulties in growing plants from that part of the country that we do with European species, and for the same reasons. Only a few of the spectacular forms characteristic of our western states can be made to succeed in eastern gardens.

Perhaps this very casual survey of vegetation through the ages will raise more questions than it answers. The subject is a complex one and many other factors than those which have been enumerated must be taken into consideration. Enough has probably been said, however, to suggest that an understanding of past events is helpful in interpreting many of the problems which face the botanist and the horticulturist. If a few of these points are held in mind, it should increase the interest of the visitor who wanders through a large collection of plants and reads the labels. As with human history, so here a knowledge of what has gone before will enhance the appreciation and emphasize the significance of what we see today.

## *LECTURE TOURS AT THE ARBORETUM*

Attention is again drawn to " discussion " tours of the 1942 season. The remaining two of this series will be held as follows:

*September 26, 2:30 P. M.*

Poisonous Plants of Farm and Garden

Leader: D. Walter Steckbeck, Associate Professor of Botany, University of Pennsylvania.

Dr. Steckbeck has studied poisonous plants in various regions of the United States and is in charge of the work in Veterinary Botany at the University of Pennsylvania. Special attention will be given to poisonous and near poisonous plants of the Pennsylvania countryside with some reference to exotics and to plants yielding drugs.

*October 10, 2:30 P. M.*

Man and Nut Trees

Leader: J. Russell Smith, Swarthmore, Pa. Emeritus Professor of Economic Geography, Columbia University.

No one has contributed more to the field of Economic Geography than Dr. J. Russell Smith. He is president of the Association of American Geographers as well as author of various texts and articles in this field, including a book, *Tree Crops, a Permanent Agriculture*. A world traveller, Dr. Smith has studied tree crops and their potentialities for permanent land improvement in many climates besides our own. He will have food for thought as well as first hand and practical information on nut varieties.

Both tours, occurring on Saturday afternoons, will commence at 2:30 P. M. at the Administration Building. They are free to everyone.

### *THE RAISIN TREE (Continued)*

stalks are sweet to the taste and are regarded as highly palatable by oriental peoples. Hovenia has never fruited at the Morris Arboretum.

The tree illustrated in fig. 8 has a height of 31 feet and a spread of 35. It was considerably larger than this before suffering severe—almost devastating—injury during the winter of 1933-'34. It is a tree capable, however, of sending strong young shoots from the main trunk and in eight years this plant has recovered its shape and size in a remarkably successful manner. In normal seasons the Raisin Tree is perfectly hardy and a highly desirable ornamental for this region.

Henry T. Skinner

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# Morris Arboretum Bulletin

November, 1942

Volume 4. Number 3



**Fig. 9. Snow Azalea**
*Rhododendron mucronatum* Don.

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# *THE SNOW AZALEA*

A recent and prized addition to the collections of the Morris Arboretum is a magnificent specimen of the Snow Azalea, *Rhododendron mucronatum,* presented jointly by Mrs. Theodore R. Keyes and Mrs. Janet R. Nevitt in memory of their parents, Mr. and Mrs. Joseph T. Ross of Germantown, Pa. Illustrated in its new surroundings on page 21, this beautifully developed plant measures 17 feet in diameter and almost seven feet in height at an age of between 45 and 50 years, and is probably one of the finest specimens of its kind in the country.

In 1921 E. H. Wilson referred to the largest of his acquaintance as growing at Winterthur, Delaware, on the estate of Mr. Henry DuPont—a plant measuring 12 feet 2 inches in diameter and 6 feet 9 inches in height. If still larger ones exist we do not happen to have heard of them.

*Rhododendron mucronatum* needs little introduction to those who garden from Philadelphia or Long Island southwards. It is the fine large flowered, pure white Azalea which has often been referred to in nurseries as *Azalea indica alba.* It is reasonably hardy in this region though requires protection farther north.

The Snow Azalea has long been a favorite in the gardens of the wealthy in many parts of China although it appears to have been introduced to the western world from Japan where it is known as Shiro-yodogawa or "White Yodogawa". The first note of its existence in this country dates from 1838, when it is recorded to have been growing in Watertown, Massachusetts.

The parentage of this white form of obvious garden origin long remained a mystery. Nowadays, however, Wilson's opinion is generally held that *R. mucronatum* is a garden variety of *R. mucronatum* var. *ripense,* a rose flowered species found wild along the river banks of southern Japan. The apparent name inversion of species and variety is a result of the fact that discovery of the wild prototype occurred after the naming of its white variety.

A similar situation obtains with the magenta Yodogawa Azalea, of which the double flowered garden form is *R. yedoense,* while the single flowered parent species, of later discovery, becomes the apparent "variety", *R. yedoense* var. *poukhanense*—a state of affairs which is readily understandable to the botanist though often distinctly confusing to the layman.

H. T. S.

# WINTER PROTECTION OF EVERGREENS

HENRY T. SKINNER

The best days of fall are past. Frosts are in the air. It is time that every gardener should think about finishing up the year's work and putting his plants to bed for the winter. A little time spent now in preparation for cold weather may save many regrets, plant replacements or visits to the plant doctor during next spring and summer. This is particularly true if garden effects rely chiefly upon the use of ornamental evergreens—either conifers such as pines, yews or cedars or the broad leaved types like the boxwoods or rhododendrons.

Not all evergreens will need protection over winter. Hardy, established plants will usually be quite all right without. It is the ones of more tender constitution, plants newly set or those in particularly exposed locations which will need attention most.

Winter injury is a rather peculiar phenomenon. It is apt to strike at a time when we least suspect that there is danger and then not be apparent in its effects until many weeks or sometimes months later. In looking over our evergreens this summer there were doubtless some of us who observed an occasional dead branch in the top of our Irish Yew or in the side of our favorite rhododendron. There were occasional dead branches this year, though very few compared with 1941. 1943 is as yet a question mark. Dying of tips or branches is not always due to winter injury but the latter is the commonest cause. Had the branches been watched earlier it would have been seen that the first sign of trouble in spring is a browning of the leaf tips. This browning is apt to spread and follow downwards until ultimately, in late summer, it may perhaps involve a large part of the tree or bush.

Injury may be often localized to a single side or part of a tree. The southern side or the side most exposed to drying winds may present a scorched appearance from April onwards. But there may also be other effects. The killing of flower buds is one. This is often a serious matter with the evergreen rhododendrons. The plant itself may appear to have wintered well and not until June when the customary flower display fails to materialize do we realize that all was not well during those cold bright days of winter.

What is the cause of these various types of injury? From the horticultural standpoint the explanation is fairly simple. We know that all plants evaporate moisture from their leaves. With deciduous plants this moisture loss is reduced to a minimum during winter when the leaves have fallen; but with evergreens water loss continues throughout the year. It may proceed at a slower rate in winter but it continues just the same. Now all water lost from the leaves must be made up for by the absorption of an equal supply by the roots if the plant is to remain in a healthy condition. If for any reason more water is lost from the leaves than is taken in by the roots certain plant tissues must suffer; the leaf cells will be dried out and they will die. This is exactly what happens in the commonest form of winter injury.

During winter, tree roots are partially dormant. The ground surrounding them may be frozen so that water becomes unavailable. If at this time the plant is exposed to drying winds, bright sunlight, low humidities, or a combination of these various conditions which encourage a rapid loss of water by the leaves, it is clear that this water cannot be immediately replaced by the roots. Winter injury will result. The part of winter when the ground is frozen hardest, when winds are dry and suns are bright falls in the month of March. This is the month when protection is most sorely needed by plants.

Newly transplanted shrubs and especially those moved late in the fall are particularly susceptible to injury because their root systems are not yet functioning properly. The danger of excessive water loss is doubly acute.

It will be seen that winter injury may not be due so much to excessive cold, as is often thought, but rather to conditions of fluctuating temperature. Extreme temperature variations and bright sunny days following cold nights are very likely to result in injury, especially, as has been said, if these bright days are accompanied by low humidities and drying winds.

This is undoubtedly the type of injury which was most prevalent during the winter of 1940-41, but, while it is probably the commonest and, when it strikes, the most severe, other forms of injury

certainly do occur, of which direct freezing is one. Unfortunately, the underlying cause of winter hardiness or its converse, frost susceptibility, are even now but little understood. The ability of plants to satisfactorily withstand more or less severe freezing is an inherited factor in that it varies with species and varieties but it is also a conditioned factor in that a given species may show different degrees of frost tolerance from year to year. In general, this second variation seems to be rather intimately related to the condition of shoots and tissues on the approach of winter. A sunny growing season with moderate rain is likely to produce well ripened shoots amply stocked with food reserves which tend to be "hardy" regardless of sudden or extreme drops in temperature. A wet, cloudy season, on the other hand, an excess of fertilizers or too late pruning may result in soft, watery and poorly ripened tissues which grow late and suffer in consequence when the first severe freezes occur. Injury to flower buds may be fundamentally attributable to "drying" as already described, but it may also merely be a matter of an abnormally late cold spell which catches them after spring development has commenced. Causes and effects are varied, and though apparently simple at first glance, in a second analysis the furnishing of explanations becomes increasingly complicated.

What are the remedies for winter injury? After it has occurred it is unfortunate that little can be done. Damaged branches should be cut back to healthy tissue as soon as possible. New branches will probably fill in again but they will take time to develop. This is an outstanding instance where an ounce of prevention is worth far more than a pound of cure. Prevention through protection is the only real solution. Before discussing protection, however, it may be well to review a few general points in the handling of evergreens which have a rather direct bearing upon the subject.

In the first place, freezing damage is most likely to occur to species freshly moved in late fall. Fall transplanting is always somewhat risky. Spring is the safer season for planting. In a normal winter, evergreens will come through satisfactorily if set before the end of October, but later moving is generally inadvisable. Evergreens should never be permitted to enter winter with their roots in a dry condition. If a period of dry weather precedes the time when the ground may be expected to freeze up, all plants should be given a thorough watering. Losses may be very serious to fall transplanted evergreens not watered in at planting time. All such plants, immediately after they are placed, should have a ridge of soil drawn up around their bases. The center hollow should be filled with water once a week until winter sets in or until soaking rains render continuation unnecessary. When transplanted, the tree should be set firmly in place so that the roots will not move and may take hold quickly. Tall specimens such as cedars or pines should certainly be braced with guy wires or ropes to keep them rigid and upright in the face of strong March winds.

It is assumed of course, in planting, that due consideration will have been given to matters of soil exposure. Bad drainage or poor soil aeration may often contribute to unsatisfactory growth and a predisposition to injury, as also will the planting of tender species in "frost pockets" or exposures especially subject to strong winds or drying sun.

With plants already established, those further details, already mentioned, should not be overlooked. Pruning and the use of fertilizers are to be watched. Vigorous pruning is objectionable after early July, nitrogenous fertilizers are for use at the *start* of the growing season. Unwisely administered, both may induce late growth subject to killing back. Even late cultivation or late rainfall, following a period when the plant was insufficiently supplied with water, may contribute to this same effect.

These preliminary precautions are important. We turn now to the other form of safeguard—protection. It has been explained that one of the major causes of winter injury is rapid water loss from the leaves occurring at a time when the roots, through being frozen, are unable to make up for this loss. The sole object of protection is to correct this situation either by reducing the rate of evaporation from the leaves or by keeping the roots in a condition in which they may function properly. Several forms of protection may be used to reduce water loss by sheltering the top and leaves of the plant. Pine boughs stuck in the ground around smaller specimens, perhaps held in place by a string encircling the plant, will often be quite adequate in breaking the force of the wind and in providing partial shade from strong sun-light. More complete protection is afforded by a cover of corn stalks, woven reeds or burlap held lightly around the plant. Entire beds of

close growing rhododendrons are often covered completely in by burlaps supported on a wooden frame. Burlaps and cornstalks, however, are not very beautiful. Pine boughs, if they can be obtained, are much more pleasing in appearance. Small plants of boxwood or English lavender can be surrounded by a strip of chicken wire, filled in with dead leaves, or they can be covered with a light shaking of buckwheat straw or saltmarsh hay. Ordinary hay contains too many weed seeds. These forms of protection should be in place by January. They serve their most useful purpose during February and March.

Protection to the roots is afforded by the use of a mulch, a covering of leaves, straw or some light material applied to the ground. A light mulch will be of assistance in decreasing rapid fluctuations in soil temperature, while a mulch of leaves two inches thick may entirely prevent the ground from freezing. More than that, it will maintain a uniform moisture supply for the roots to draw upon. A good mulch should be applied to every evergreen moved in the fall, to every plant that is likely to be susceptible to winter injury, and for the purpose several materials can be used. Leaves and straw have been suggested. Spent tan bark is normally obtainable from the leather mills, though it may be in too great demand at the moment for government camouflage purposes. It is quite acid in reaction and is particularly useful as a mulch for rhododendrons and other acid soil plants. A covering such as this may be left in place all the year through for it will be beneficial in summer as well as winter. Hardwood sawdust has a similar use for acid soil plants. Two other materials have definitely come to the fore for mulching purposes in recent years and should be mentioned even though the first, and certainly the second, may be on "other demand" this season; one is ordinary wood excelsior, the other is fiber glass or glass wool. Both of these may be applied in November, removed again in early spring and can then be stored for use in future seasons. It is likely that they will be as valuable in the case of evergreens as they have already proven in the care of perennials. All mulches should be in place on the soil surrounding the plant by mid November and before the ground has frozen to any great extent.

Another form of winter injury should perhaps be mentioned—snow damage or the direct breakage caused by a heavy wet snowfall. This can never be severe if proper attention is given to shaking the plants off immediately after they become weighted down and before the snow commences to thaw. If attention is not immediate, too frequently a frost will follow and the snow burden, frozen fast, may remain for several days, bending the branches and perhaps effecting a permanent ruination to the appearance of the plant. Snow is apt to be most harmful on slender branched types such as oriental arborvitae or the multi-branched junipers. The danger can, however, be minimized by binding a few strips of burlap or strings around these plants in fall. They will hold the branches together and prevent spreading under the weight of wet snow.

The planting of specimens in groups so that they will help to protect one another or the choosing of sheltered locations are good practices to follow, particularly when growing the more tender specimens. The methods of old man winter are insidious and very persistent. Effort on our part is needed now if *all* our plants are to look their best when spring opens up next year.

## *AN EXPERIMENT IN GREENHOUSE BENCHES*

In the propagating and experimental greenhouse built in 1941 at the Arboretum it was desirable to install wooden benches. For various reasons slate, hollow tile, concrete, etc., types were less well adapted. But wooden benches as usually built have a distressingly short life. The conditions of moisture and warmth obtaining in greenhouses are so favorable to the growth and activity of wood-rotting fungi (to which almost all wood decay is due) that ordinary wood benches last but comparatively few years.

But there are at least a few kinds of wood available which are extraordinarily resistant to decay. Following the Arboretum policy that even ordinary utilities be made to yield, where possible, some by-product of educational or experimental interest, it was decided to build the

benches out of one of these woods, namely, that of Black Locust (*Robinia Pseudoacacia*).

This native of the eastern United States is one of the most familiar trees about homesteads, and has become widely naturalized east of the Rockies. Besides its merit as a flowering shade and ornamental tree, it has long been valued for its decay-resistant wood, a quality well known to the Indians. For several centuries it has been sought after for fence posts, sills, and other uses where durability in contact with the soil is important. Of peculiar interest is the prominence it attained in furnishing " treenails " or " trunnels " for constructing wooden ships.

These treenails (the thick long wooden pins holding together timbers, beams, knees, etc.) were subject to great stresses; and with the onset of decay, even slight, these strategic elements commonly sheared off, with obvious serious consequences. Black locust treenails used in the Colonies largely overcame this difficulty owing to their great strength combined with amazing decay resistance. Indeed, a member of Parliament rose to point out that unless the British Navy adopted black locust treenails it could not hope to equal the American ships. By about 1820, Philadelphia alone exported between 50,000 and 100,000 locust treenails to England annually.

Increasingly it has been recognized that there are varieties, races, or clones of black locust differing in decay resistance. Of these the best known is the so-called Shipmast Locust, *Robinia Pseudoacacia* var. *rectissima,* described from Long Island, New York, as a separate botanical variety by Raber in 1936. The name " shipmast " refers to the straight erect trunk in contrast to the more spreading habit of the so-called " common " locust. Introduced into Long Island apparently over two centuries ago from an uncertain source (possibly tidewater Virginia), the lasting qualities of its wood long ago became well known to Long Islanders. Fence posts still sound after one hundred years or more in the ground appears to be a well authenticated fact. Indeed, on occasion posts pass not unlike currency—resold after long service to be again set as posts.



Fig. 10. Two partially constructed benches. The side boards are in place but only one bottom board at each edge, leaving the supporting cross pieces largely visible. The third bench also constructed of shipmast locust is barely visible on the left beyond the partition.

Out of the wood of this extraordinary tree the greenhouse benches were built. The 2″ by 4″ supporting cross pieces were secured from the sawmill operated by Harned Brothers near Commack, Long Island, from boards which had been air-seasoned for several years. Since the boards from which the pieces were sawn had the very characteristic bark of Shipmast Locust adhering on one or both edges, definite identification was possible. The bottom and side boards, averaging $1\frac{1}{8}$″ in thickness and sawn by the Watson Lumber Service Co. mill at Jericho, Long Island, from freshly felled trees, were air-seasoned for nine months before installation. The trees were inspected by us before felling and identified as the genuine shipmast variety. No preservative was applied to any of the lumber used.

Shipmast Locust has probably rarely been used for greenhouse benches, and never, so far as known, with definite records. Therefore an account is here published of the source, botanical identity, etc., of the wood out of which in the summer of 1941 the benches were constructed through the admirable craftsmanship of Mr. Thomas J. Carney.

The absence at present of data on the lasting qualities of shipmast locust wood under greenhouse conditions precludes a reliable estimate of the probable life of the benches. But from what is known of the performance of the wood under other conditions likewise favoring decay, long life is confidently expected. Perhaps the report chronicling the conclusion of the experiment will be written and read only by our descendants.

J. R. Schramm

# NOTES FROM THE LABORATORY

## Root Distribution Studies

During the last few years, more and more attention has been paid to the lateral distribution of the roots of trees in answer to the questions concerning the most beneficial areas in which to do fertilizing. According to the older literature, the mycorrhizal or feeding roots of trees were to be found localized in an area which in general was covered by the " drip " from the outer edges of the crown spread. More recent work has shown that, while differing greatly among the species, the area in which the mycorrhizal roots are abundant may be anywhere from the root crown out to a considerable distance beyond the ends of the crown spread. In fact, Gourley and Bechenbaugh (1932) found in their studies of roots of Apple trees that there were fewer feeding roots directly under the drip than within or without this area. Studies at the Arboretum in the past few years have been directed along the lines of determining the lateral root distribution of some of the ornamental conifers. Some of these results have already been published.*



FIG. 11. Root system of *Pinus nigra austriaca*

This past summer another system was laid bare and is here noted. An Austrian Pine (*P. nigra austriaca*) having a d. b. h. of 21 inches, crown spread of 26 feet and height of a little over 50 feet was studied. Its case-history included a fertilizing, two years prior to this, at which time Michigan peat, ground limestone and bonemeal were applied in a very shallow trench in a 4-foot band with its inner circumference 13 feet from the trunk (about at the edge of the crown spread). The studies were made by soaking the ground thoroughly for several days prior to excavation. In the actual uncovering work, water was first used to gently wash out the soil for examination of mycorrhizae in situ. This was followed by washing with a fast stream of water from a hose. The latter laid bare all roots of the major part of



FIG. 12. Root system of *Cedrus atlantica*

* " Fertilizing Precautions to Tree Men," *Arborist's News*, Vol. 6, No. 6, pp. 41-43, June, 1941.

the system in a trench 3 feet wide, over 21 feet from the trunk outward and about 1 foot deep. The accompanying plate (fig. 11) shows the results, each white marker designating 1 foot and the white band showing the area of the circumferential fertilizing. The greatest massing of mycorrhizal roots was in the area from 3 to 8 feet from the root crown—which had been overlain with a thick layer of humus from the normal fall of pine needles. Good mycorrhizal roots were found on all parts of the system out to the end of the trench—21 feet.

Figure 12 shows the root system of an Atlas Cedar (*Cedrus atlantica*). This tree had a d. b. h. of 12 inches, crown spread of 22 feet and height of about 37 feet. Previous fertilizing with commercial fertilizer plus Michigan peat and bonemeal had been done by the shallow-trench method in a band 4 feet wide, its inner limit being 8 feet from the trunk. In this case, the trench which was washed out for the root study was 3 feet wide, over 15 feet long and 3 feet deep. The rather meager root system is seen to be concentrated very close to the root crown, extending out only a little over 3 feet for the major portion, and the furthest extent of any root being not more than 8 feet.

These are just two more illustrations to add to accumulating results which should generally discourage the continuance of this particular method of fertilizing, i. e., the band method—whether applied by trenching or the punch-bar. The ideal prelude to any tree fertilizing would be a sampling of the area to determine the general lay-out of the major part of the root system. While it is contended that the band method of feeding is useful in attracting the roots outward, it must still be recognized that nutrients—particularly phosphorus, move very slowly through the soil. Thus if the fertilizers are not reasonably close to the roots which they are to "feed", no appreciable good may be derived.

Spencer H. Davis, Jr.

### Poplar Canker. A Note On the Susceptibility of Various Poplar Species

In a recent survey of poplars growing in the Arboretum nursery, the following nineteen species and varieties, with diameters varying up to seven inches, were noted for their susceptibility or resistance to *Dothiciza* canker. The trees were growing in successive rows, thus having equal opportunity of becoming diseased.

Species and varieties showing no cankering:

*Populus alba nivea*
*P. alba Richardii*
*P. brevifolia*
*P. euphratica*
*P. generosa*
*P. Maximowiczii*
*P. tomentosa*
*P. trichocarpa*
*P.* Geneva

Those in which cankering was severe or in which the majority were cankered:

*P. acuminata*
*P. berolinensis*
*P. canadensis*
*P. nigra betulifolia*
*P. nigra italica*
*P. Petrowskyana*
*P. Przewalskii*
*P. Sargentii*
*P. Simonii fastigiata*
*P. suaveolens*

Poplars as a group are often held in rather low esteem for ornamental plantings. While it is true that unfortunate root habits, brittleness and suckering tendencies make them poor trees for use in the city, much of this distrust almost certainly stems from the readily observable susceptibility of one species—the Lombardy—to Poplar Canker. The above observations lend emphasis to the fact that a number of desirable poplar species are relatively canker resistant.

Spencer H. Davis, Jr.

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# Morris Arboretum Bulletin

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**Fig. 13. On a Caucasian Alpine Meadow**
*Campanula tridentata, Alchemilla,* and
(flower, lower right) *Saxifraga sibirica*

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## THE ASSOCIATES OF THE MORRIS ARBORETUM

The ASSOCIATES, through whose interest and generosity this *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# *A GIFT WEATHERVANE*

Latest addition to the new Laboratory and Service Building adjacent to the greenhouses—and one which greatly improves its appearance—is an excellently finished steel weathervane, personally made and presented to the Arboretum by Mr. Thomas Williams of Dravosburg, Penna.

When visiting the Arboretum a year ago Mr. Williams recognized the need for a detail of this sort to improve the appearance of the small, central, ventilating tower. He accordingly acquired materials and set to work with the result as illustrated in the accompanying figure. The design is essentially a reproduction of a Colonial weathervane, with the addition of a copper ball to add height to the copper dome beneath. The scroll work, cross pieces and ball-bearing mounted vane are entirely hand-forged of fine quality steel and are each removably attached to the 6 foot supporting rod, the whole providing a useful as well as ornamental unit which is especially pleasing against the background of surrounding trees.

The Morris Arboretum appreciates this very personal gift of Mr. Williams.

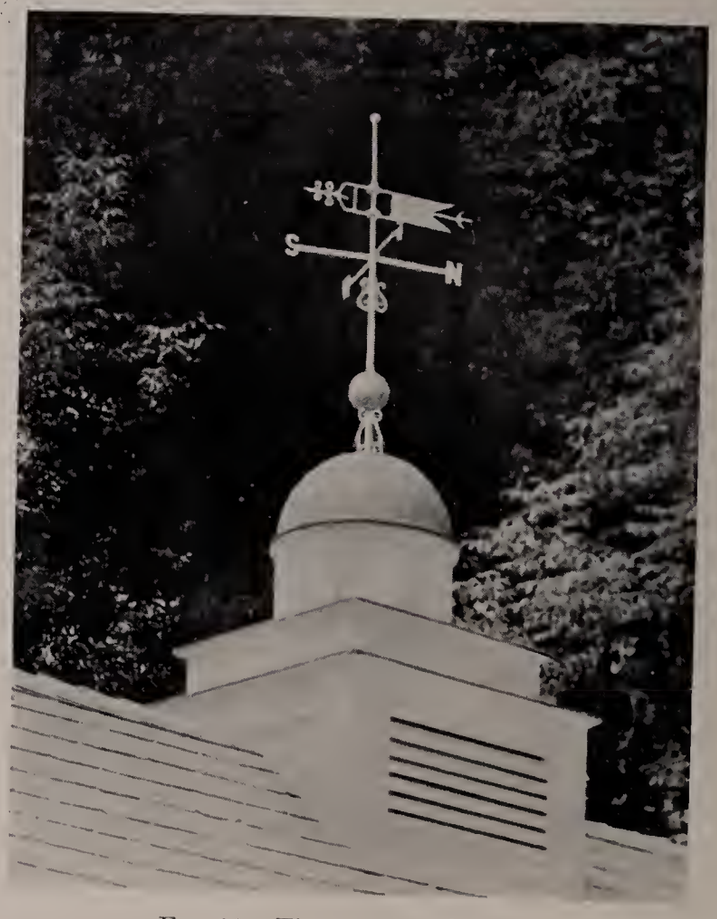



Fig. 14. The new weathervane

# THE PLANT LIFE OF THE CAUCASUS

William Seifriz

Recently on reading that the Russians were defending Nalchik among the foothills of the Caucasus, memories of that picturesque town crowded into my mind. I recalled wandering through the market there in 1931. It was more than just a market. It resembled a fair in the variety of its foods and household goods, and the gaiety of its people. I asked the price of soap; six dollars a pound. Again and again I was offered all the paper rubles I could hold for my camera. The sheepskin coats made of blankets sewn together, the bright trappings, and the magnificent riding of the Cossacks all took my fancy. The men seemed to be extraordinarily fit. There is an old Russian proverb which says that Caucasian men are brave and all the women beautiful, to which there is some truth. But Nalchik was only an interlude to a strenuous botanical expedition in the Caucasus.

The Caucasian Mountains offer an extraordinary variety in plant life.[1] South of the Main Range are the luxuriant forests and fields of Svanetia. Farther south still, lie the semi-deserts of Tiflis and the sub-tropical shores of the Black Sea. In the Minor Caucasus are the garden spots of Borjom and Bakuriani, and the parched hills of Armenia. North of the Main Range is the endless expanse of the Russian steppes.

The vegetation of the North Caucasus differs greatly from that of the South. The northern slopes, from Mt. Kazbek on the east to Mt. Elbrus on the west, are rocky and precipitous, with insufficient grass for grazing. The southern provinces supply the northern ones with hay, and surpass the northern ones in wealth of forests; but the northern Caucasus have some of the finest natural flower gardens in the world.

The Caucasian flora is prolific with many endemics — species and varieties found only within this region. This is evident from the frequent occurrence of the term *caucasica;* some fifty species bear that name. There is a humorous saying among Russian botanists that when in the Caucasus if you do not know the specific name of a plant, guess *orientalis;* if wrong, then guess *caucasica* and you are certain to be right! Plants, like people, seem to have stopped there in their migratory journeys—nineteen different languages are spoken in the Caucasus. The uniqueness of plant life is due to the high barrier formed by the mountains, separating regions of wholly different climate.

On the day following my visit at Nalchik, we got into a truck and rode up the valley of the Baksan into western Balkaria, to the little village of Tegenekli at the foot of Mt. Elbrus. Elbrus is Europe's highest mountain, topping Mt. Blanc by 2500 feet.

The views into the successive valleys toward the Main Caucasus Range were exquisite. I asked my Russian friends how they thought the Caucasus compared with the Swiss Alps. "The Alps?", they replied, "a mere toy compared to the Caucasus." This is a bit of a Russian boast, for the Russians are a proud people; yet the Caucasus *are* superb.

Each valley offered a distinct botanical problem, and to a surprising extent a different flora as well. I shall describe three of them. The first was the valley of Adyl-Su with a sparse vegetation, for the glaciers descend low. Here I had opportunity to study the tree line, which in the Caucasus may be of pine, spruce, or birch.

The Caucasian pine is a problem in both taxonomy and ecology. It may be the European pine, *Pinus sylvestris,* or a variety of it known as *P. hamata,* or we may settle the problem and call it *P. caucasica.* Its distribution is also a puzzle, for in the North Caucasus it is on the southern slopes, and in the South Caucasus it is on the northern slopes.

The second of the valleys was that of Uzengi. Here was as beautiful a forest of birch as one could imagine. The trees shimmered in the sunlight like spangles on a ballet dancer's dress. If one were to choose just one tree with which to represent all Russia it would be the birch. Russian artists delight in putting the birch in their landscapes. The remarkably sharp distribution of trees in the Caucasus was again illustrated in the

[1] For a more detailed account see the writer's "Sketches of the Vegetation of Some Southern Provinces of Soviet Russia", II, III, VI, and VII, of *Ecology*, Vol. 19, 1931, pp. 372-382; Vol. 20, 1932, pp. 53-68; Vol. 23, 1935, pp. 140-160.

Uzengi Valley; birch was on the north-facing slopes and pine on the south-facing ones.

The third valley was that which leads to the western pass over the Main Caucasus Range, the Dongus-Orun, a valley of supreme beauty, headed by majestic peaks and glaciers. The vegetation




Fig. 15. Location map of the Caucasus. Scale 1 : 8,000,000

here was quite another one, a true alpine, or rather sub-alpine, flower garden in meadows of high grass. The genera are familiar to us as alpine plants, or if we are not alpinists, we know them in our rock gardens. Even the prostrate juniper is there. It is common throughout high Russian mountains, from the Caucasus to the border of Chinese Mongolia, as it is on our northern moors from the coast of Maine to Labrador. How truly alpine is this Caucasian mountain flora can be seen from the following selection:

*Juniperus communis depressa*
*Calamagrostis arundinacea*
*Silene commutata*
*Aconitum orientale*
*Allium paniculatum*
*Alchemilla retinervis*
*Trifolium alpestre*
*Astragalus galegiformis*
*Viola lutea*
*Daphne* sp.
*Bistorta* sp.
*Polygonum alpinum*
*Dianthus liboschitzianus*
*Sempervivum pumilum*
*Saxifraga scleropodia*
*S. cartilaginea*
*Epilobium montanum*
*Gentiana caucasica*
*Myosotis alpestris*
*Ranunculus orcophilus*
*Alyssum murale*

As we stand at the entrance to the Dongus-Orun Valley, the Main Caucasus Ridge is in front of us to the south, and beyond it the Black Sea. At our backs, to the north, lies the great Elbrus, its two peaks resting like mammoth snow-white igloos on the earth's surface. The highest is 18,347 feet above the sea.

Another day or two was spent at Tegenekli listening to old Ali tell tales of the days before the Communists, days when many old customs were rigidly kept, such as housing young girls in dark rooms for six months before marriage so as to thoroughly bleach them out for their husbands.

The slow climb up Elbrus then began. My eyes were directed ever toward the white glistening summit unaware of the more dramatic scenery at my back until I stopped to rest. There before me lay the most magnificent valley that I have ever beheld, a sublime picture of one of Nature's great masterpieces (Fig. 17).

A valley such as that of the upper Baksan illustrates well what the altitudinal distribution of plants really means. The sketch in Fig. 18 diagrams this for another Caucasian valley.

Higher still on Elbrus is mountain tundra. It carpets the little plateau known as Krugozor, close to the edge of the glaciers. Immediately below was a sub-alpine brush of *Sorbus Aucuparia,* so typical of Russian mountains, of Prunus, Salix, *Rubus saxatilis,* the ubiquitous *Vaccinium Vitis-idaea,* Berberis, *Hippophaë rhamnoides,* and Rosa. Typically, and historically, Russian tundra is high mountain moorland, not arctic lowland, but the plants on both are very similar. The tundra on the high slopes of Elbrus contains plants common to both alpine and arctic fields:

*Botrychium lunaria*
*Dryopteris filix-mas*
*Avena versicolor*
*Carex caucasica*
*Crocus* sp.
*Gymnadenia conopea*
*Minuartia caucasica*
*Silene lychnidea*
*Saxifraga sibirica*
*Polygala alpestris*
*Empetrum nigrum*
*Daphne glacialis*
*Valeriana alpestris*
*Gnaphalium supinum*
*Antennaria dioica*
*Anthemis iberica*
*Draba begardes*
*Polygala alpestris*
*Veronica gentianoides*
*Aster alpinus*
*Taraxacum ceratophorum*
*Linnaea borealis*

I had always associated *Linnaea borealis* with arctic moors. To find it so far south was a sur-





Fig. 16 (Top). The central Caucasus Range, Mt. Tetnuld at left; alpine hills in foreground covered with Rhododendron and Geranium

Fig. 17 (Bottom). Valley of the upper Baksan, approaching Mt. Elbrus, Balkaria

prise, but the reason is evident: *Linnaea borealis* thrives in the Caucasus because of altitude. Whether one travels *north* from the equator or *up* from the equator, the change in plant life is the same, from palms to arctic moors or alpine fields.

The renowned edelweiss is not found in the Cau-

casus. It skips all mountains from Switzerland to Japan, and reappears in Nippon's alpine meadows.

The valley of the Dongus-Orun, which we visited before the climb up Elbrus, is the route to one of the least known and most unreal valleys on earth, Svanetia. The only familiar country to which I can compare it is Andorra in the Pyrenees.

Svanetia is a dreamland, nestled between two high mountain ranges, and inhabited by the Svans, a people long feared by the Russians. To but briefly characterize the plant life of Svanetia would require many pages. I shall, therefore, tell of just three of my most stirring experiences there. The first occurred just over the pass where we entered the high grass, a sub-alpine vegetation. This was truly high grass. Never have I seen such tall alpine plants, with such colossal flowers. The yellow blossoms of Inula were as large as sunflowers, and the blue bells of *Campanula latifolia* were 'most large enough to ring. But the giant among the Nakra Valley herbs was Heracleum,—it towered above me to a height of twelve feet. I cannot show you a picture of this Heracleum, but you can see it in one of the finest books ever written on the Caucasus, that of Douglas W. Freshfield, superbly illustrated by Vittorio Sella.

The second impressive feature of Svanetia's vegetation is her forest of firs. Monarchs such as these leave one in awe. We slept on straw under the giant Abies after a supper of tea and shashleek.

The next morning brought us into Svanetia proper, into the valley of the Ingur. It seems almost sacrilege to pass so hurriedly through this valley of unsurpassed beauty, ignoring its forests of Populus, Fagus, Quercus, Acer, Tilia, and Juglans, which, if we are to judge by the genera, might almost be a forest in Pennsylvania. There is Ilex, Corylus, and Prunus as well—wild pears are abundant in the Caucasus. We must pass by, too, the majestic splendor of the mountains, the monolithic Ushba dominating all. One additional glimpse of the plants of Svanetia I shall give, however, on a little patch of ground high above Mestia. Mestia is a village of towers where every home has a stone fortress resembling a Campanile.

Growing within a foot of each other, on rocky ground at the edge of an alpine wood of shrubby beeches, was an association of plants typical of the far north. Here were *Vaccinium Vitis-idaea, Linnaea borealis, Empetrum nigrum, Goodyera repens,* and *Pyrola secunda,* which I had collected on the arctic moors in Russian Lapland, latitude 69°.

We leave Svanetia by the Latpar Pass. The Russians have a saying, " He who goes over the Latpar Pass in fair weather is blessed by God." From the Latpar Pass one has an unobstructed view of the Main Caucasus Range.The panorama is one of unsurpassed grandeur. The ruggedness of Shkara's rocky ridge is softened by freshly fallen snow, and the white cone of Tetnuld, the most graceful of the Caucasian peaks, glistens in all its splendor (Fig. 16). At one's back, to the south, lies the more serene pastoral landscape of Georgia.

The high alpine fields here at 10,000 feet altitude were covered with an almost pure growth of but three plants, a grass, a geranium, and a rhododendron. The geranium was *Geranium pasturus;* it covered square miles of ground. The rhododendron was *R. caucasicum.* Only one other plant did I take note of; in a slight depression on the meadows at the Pass, *Crocus flavus* was growing in extraordinary profusion.

On to Batum we went, where luscious ripe figs and airon, the healthful sour milk of Southern Russia, were a refreshing change from the heavier diet of the mountains.

The foregoing journey is a severe one and rarely taken by visiting botanists or Russians. A more comfortable trip, and almost as fine in its scenery and plant life, is that among the hills of Bakuriani in the Minor Caucasus bordering Armenia. There is not space to describe these hills in detail but I can do it botanically, and briefly, by summarizing with the aid of a sketch (Fig. 18). The figure depicts the altitudinal distribution of plants, from the valley floor at 5000 feet altitude to the ridge of Tzhra-Tzharo at nearly 10,000 feet.

No. 1 on the figure (Fig. 18) represents lowland pastures with the wild pear, *Pyrus communis,* the wild apple, *P. malus,* and an occasional wild plum, *Prunus divaricata.* Grasses and numerous Carices cover the pasture floor.

No. 2 is of lowland forests of *Ulmus elliptica, Corylus Avellana, Acer platanoides, Quercus macranthera, Alnus glutinosa,* and *Fraxinus excelsior.*

No. 3 represents lowland forests of the pine, *Pinus hamata,* and the spruce, *Picea orientalis.*

No. 4 is of the upper deciduous forest consisting primarily of the endemic maple, *Acer Trautvetteri,* with a few scattered oaks, the last beeches, and first birches. The Caucasian maple reaches the tree line in many regions of the mountains.




Fig. 18. Panorama of Tskhra-Tskharo, Minor Caucasus, showing altitudinal plant zones

No. 5 is the tree line; an open forest of the birch, *Betula pubescens,* if on the north slope, and *Pinus hamata* if on the south slope. If the slope is squarely to the east or west, pine and birch are intermingled.

No. 6 is of park-like fields at the tree line containing fine tall-stemmed alpine flowers such as *Campanula lactiflora, Heracleum Wilhelmsii, Podanthum campanuloides, Betonica grandiflora, Aethiopappus pulcherrimus,* and *Gentiana asclepiadea*—the tallest of the gentians.

No. 7 is a thicket of *Rhododendron caucasicum* and *Vaccinium uliginosum.*

And No. 8 is of alpine fields of short grass, Poa predominating, but Koeleria is abundant. Here grows a magnificent collection of alpine flowers with *Dianthus cretaceus, Ranunculus caucasicus, Anemone narcissiflora, Helianthemum vulgare, Aconitum anthora, Primula cordifolia, Alchemilla vulgaris, Onobrychis oxytropoides*—a typical Armenian plant,—*Trifolium canescens,* and the tiny prostrate rosaceous *Sibbaldia parviflora.*

A still more leisurely promenade—it is little more than that—is the walk, or ride, along the renowned Georgian Military Way, through the Daryal Canyon, from Tiflis to Vladicavas, or what *was* Vladicavas — Russians have changed the names of their towns so often since 1918 that one can't keep up with them. I believe Vladicavas has become Ordzhonikidze. Pronounce it if you dare!

The Georgian Military Way is famed in Russian history as the scene of many an encounter between the Russians and the Gruzini (Georgians). It is equally renowned for its magnificent scenery; the Daryal Canyon and Mount Kasbek are known by name to every Russian school child.

The Georgian Military Way has been trod not only by soldiers but by botanists. There is great diversity in habitat and, therefore, in vegetational type, from Russian steppes to lowland forest, mountain grassland, highland forest, cliff plants, sub-alpine high grass, and alpine fields. We cannot do it all, so I shall select that part which would give the greatest joy to a garden lover. It is the flower-laden, sub-alpine high grass on the slopes of Mt. Kasbek.

I had just emerged from a small woods of *Crataegus melanocarpa.* That the hawthorn could be so abundant I never realized. Clinging to the rocky crags of the canyon were dwarf forms of *Pinus hamata,* and occasional prostrate Junipers, with clumps of *Berberis georgica. Sempervivum caucasicum* flourished well, tightly rooted in rock crevices, as is the habit of this genus. There was also the delightfully jaunty *Pyrethrum parthenifolium,* a less familiar genus among the asters.

As I entered the high grass, I met a group of students from the University of Moscow and they immediately turned to collecting plants I had not yet found. These were among them:

Caryophyllaceae
*Alsine imbricata*
*Dianthus alpinus*
*Minuartia imbricata*
Ranunculaceae
*Aconitum caucasicum*
*Delphinium flexuosum*
*Ranunculus boissieri*
Papaveraceae
*Papaver bipinnatum*
Crassulaceae
*Sedum oppositifolium*
*Sempervivum caucasicum*
Saxifragaceae
*Parnassia palustris*
Rosaceae
*Fragaria elatior*
*Rosa dumetorum*
*Rubus idaeus*
Leguminosae
*Medicago glutinosa*
Geraniaceae
*Geranium pyrenaicum*

Thymelaeaceae
*Daphne glomerata*
Umbelliferae
*Astrantia biebersteini*
Ericaceae
*Vaccinium Vitis-idaea*
Oleaceae
*Ligustrum alatum*
Gentianaceae
*Gentiana asclepiadea*
Labiatae
*Betonica grandiflora*
*Mentha silvestris*
Dipsacaceae
*Cephalaria procera*
Campanulaceae
*Campanula collina*
Compositae
*Centaurea dischori*
*Doronicum macrophyllum*
*Inula helenium*
*Pyrethrum parthenifolium*
*Solidago virga aurea*
*Swertia iberica*

One of the loveliest of the blossoms was that of *Scabiosa caucasica.*

Higher, in the crevice of an exposed rock, was the sprightly *Campanula tridentata* (Fig. 13). It might well be chosen as symbolic of the ruggedness and beauty so perfectly combined in the Caucasian Mountains.

# *NOTES FROM THE LABORATORY*

## Spray Results

*Nicotine on Larch Case Bearer.*—In the past, arsenate of lead has been relied on to control heavy infestations of this pest (*Coleophora laricella*) on the American Larch (*Larix laricina*) at the Arboretum. This has meant two and sometimes three spray applications over a three-week period to keep the new foliage covered and protected against the larvae. For the first time at the Arboretum a contact insecticide was used last spring. Nicotine and C. P. O. (1–2–800) was the application made on the 17th of April—at which time the trees were beginning to "green" and the larvae becoming active. This single spray completely controlled a very severe infestation on all the larch.

*Arsenate on Cypress Tip Moth.—Recurvaria apicitripunctella,* which is a serious pest on the bald cypress (*Taxodium distichum*), but does not attack the pond cypress (*T. ascendens*), has been readily controlled with an arsenate of lead spray. Applications at the time of "greening" and again ten days later were sufficient. Of contact sprays, nicotine was found to be impractical in that any dosage heavy enough to control the insect caused severe burning of the foliage. "Lethane 440" caused no burning, but its insecticidal value on this insect was not completely satisfactory.

*Yellow Cuprocide on Pine, Hawthorn, Rose, and Calycanthus.*—For the past two seasons this spray (1½-100) has been used as a control of the *Sphaeropsis* tip blight on the pines. Results, while not so consistent as with Bordeaux, have been satisfactory. However, foliage burning, and in some cases complete defoliation, was found on some smaller plants, namely, Azaleas, *Pyrus japonica,* Enkianthus spp., and *Osmunda regalis,* which were affected by the spray drip from the pines.

English hawthorn, which had been sprayed for leaf-spot with Bordeaux with excellent results a year ago (*Morris Arb. Bull.,* Vol. 4, No. 1), was sprayed with Cuprocide during the past season. Results, while satisfactory, were not so favorable as with the former.

An *Alternaria* leaf spot of the Carolina Allspice (*Calycanthus floridus*) has been almost completely controlled with Cuprocide used in mid-May, first of June, and mid-June.

At the rate of 2⅓ ounces of Cuprocide to 100 gallons, black spot of roses has been kept under control by spraying every two weeks.

SPENCER H. DAVIS, JR.

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# Morris Arboretum Bulletin

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FIG. 19. *WEEPING YELLOW CYPRESS.*
*Chamaecyparis nootkatensis pendula* (Beiss) *Schneid.*

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# Weeping Yellow Cypress

Among the handsomest of all evergreens at the Morris Arboretum is an eighteen foot specimen of a weeping form of the Yellow or Sitka Cypress, *Chamaecyparis nootkatensis pendula,* illustrated on the cover.

The type species, *C. nootkatensis,* is indigenous to the mixed coastal forests of the Northwest, from Prince William Sound, Alaska, south to the Cascade Mountains of Washington and Oregon almost to the California line, and while it often grows in somewhat inaccessible places for lumbering, its timber is greatly valued for decorative woodwork, fetches a high price, and has been described as "the finest of all North American coniferous woods." This tree has proved both hardy and successful in the Eastern States and, although not common, is none the less fairly frequently met with on estates and in most arboretum collections. It is essentially broad pyramidal in habit and is enjoyed for its green or grayish, finely divided foliage borne on slender ascending branches.

The subject of this note, however,—the weeping form,—is as distinct from the type in grace and attractiveness as it appears to be rare in this country. More than one weeping form has evidently been recognized, for one with extremely pendulous branches was figured in *The Gardeners' Chronicle* in 1906 which seems to be quite distinct from a second form named by Beissner and introduced to England at an earlier date. This second form is said to have nearly horizontal primary branches with only the branchlets pendulous,—a description which corresponds reasonably well with the specimen at The Morris Arboretum for the weeping effect is here sufficient to impart grace without in any way approaching the grotesque. With this particular plant the primary branches happen to be ascending rather than horizontal but, be that as it may, it is an admirable tree.

*Chamaecyparis nootkatensis pendula* has never received winter protection at Philadelphia and has only once been injured—by an ice storm some years ago which broke its leader. Recovery, however, was rapid so that the injury is no longer apparent. This variety is normally available from a number of European nurseries but does not appear to be commercially listed in the United States.

H.T.S.

# A Wartime Retrospect

Once again THE MORRIS ARBORETUM BULLETIN resumes normal publication. The last issue (Vol. 4, No. 4) appeared in February, 1943. By that time the Arboretum, like any other enterprise, had abundantly felt the effects of war. Reductions of its staff in favor of wartime industry, research, and the armed forces was unavoidably paralleled by restriction of activities. Among the casualties was the *BULLETIN*. A three year lack of this means of contact with associates and correspondents of the Arboretum has been regretted. Both satisfaction and encouragement have been found, however, in numerous indications of the patience and continued interest of our readers, and it is to be hoped that future returns through the medium of these pages will prove this confidence to have been justified. Our thanks are especially due to the many individuals and organizations on our exchange list who have continuously maintained their contribution of periodicals, magazines and bulletins throughout this difficult period with so little return on our part.

As was to be expected, the war years saw numerous changes, temporary and permanent, and unfolded new fields of endeavor for various staff members in both the Arboretum and the Department of Botany. The first loss to the Arboretum staff occurred in 1942 when Arthur Streeper, vehicle driver, severed connections, after six years, in favor of the Atlantic Refining Company. Arthur subsequently joined the U. S. Navy and saw considerable ocean travel before securing an honorable discharge in December, 1945.

In February, 1943, Joseph W. Adams, curator of the Herbarium, turned to war industry and the Philco Corporation where he was engaged for two and a half years as machinist, making fixtures and jigs for radios and communications. During this time, however, he still maintained connection with the Arboretum and provided especially valuable week-end assistance in helping to forward the Arboretum's labelling project. He rejoined the Arboretum staff in his former capacity in November, 1945.

In April, 1943, Angus Mackenzie, gardener, after ten years of service with the Arboretum and five years with the Morris estate, turned to war industry as a master rigger in the Sun Shipyards, where he continued until May 1st.

In July ,1943, Henry T. Skinner, Curator, relinquished his duties at the Arboretum to become a Camouflage Technician in the 939th Aviation Engineers of the United States Army. Assigned to the First Air Force, he spent many subsequent months in travelling the airfields from Florida to Maine and the Midwest, giving instruction in camouflage and demolitions to fighter and bomber crews preparing for overseas movement, and in preparing manuals and instruction material for this purpose. It seems that camouflage of a B-29 entails techniques which had been little thought of in the last war and even the knowledge of how to transplant a Pin Oak or Arborvitae was not much help in the case! With air superiority gained, the need for camouflage decreased proportionately and in 1945 Skinner transferred to the Quartermaster Corps. After four more months of service he achieved a permanent leave from the Army and was welcomed back to the Arboretum in October.

There was one further permanent loss in Mrs. Peggy Kimes, Arboretum Secretary, who resigned in December, 1943, after two years of service in order to devote full time to her increasing family.

As was to have been expected, at the Department of Botany as well as at the Arboretum, normal routines were very definitely affected during this period.

Commencing during the summer of 1942 and continuing until recently, Professor Wesley G. Hutchinson was on leave of absence to carry on work under a contract held by the Johnson Foundation with the Office of Scientific Research and Development. This work has been concerned with the study of the deterioration of military material under the conditions of the humid tropics and with methods of preventing such deterioration. In connection with these studies Dr. Hutchinson made four trips to the Central American tropical areas. Two to four men were engaged in investigation at a research testing station established in that area, while an additional five to seven conducted research at the Department of Botany where a specially constructed greenhouse chamber permitted the testing of a wide variety of army and industrial equipment under simulated tropical conditions. Results of this work, at the time confidential, were described in monthly progress reports and summarized in five bound manuscripts.

Dr. Spencer H. Davis, Jr., relinquished his duties as Assistant Pathologist at the Arboretum in 1942 to assist in the above project. His earlier studies were followed at the Arboretum and the

Department of Botany, to be continued at the tropical research station at Frijoles, Panama. During a return visit last spring he married Miss Emily J. McElwee of Philadelphia who subsequently accompanied him to Panama for the remainder of the year. Dr. Davis is now engaged in fungicide research in the Department of Plant Pathology of the University of Delaware.

Three members of the Department of Botany became engaged in the rubber research program. In this connection Professor William Seifriz spent three and a half months in Haiti on research primarily concerned with the electrophoretic properties of *Hevea, Castilloa* and *Cryptostegia* latex, and a correlation of their electrical properties with coagulation and acidity. Results of these studies have appeared in the August and September (1945) issues of *India Rubber World.* Dr. Seifriz's sojourn in Haiti was rounded out by twelve lectures at the Medical School which, considerably augmented, are now about to be published in French under the title "La Substance Vivant" at Rio de Janeiro. Results of studies during a subsequent and shorter visit to the Government Experiment Station at Coconut Grove, Florida, were published in *Science* under the title "The Coagulation of Latex."

Dr. Paul J. Allen, Instructor, was granted a leave of absence in February 1943 to engage in war emergency research on new biological methods of extracting rubber from supplementary rubber plants, notably *Cryptostegia* and *Guayule.* By this time the East Indian pre-war source of well over 90 percent of our *Hevea* rubber was cut off. Dr. Allen was stationed first in Philadelphia at the Eastern Regional Research Laboratory of the U. S. Department of Agriculture and later at the Salinas, California, Laboratory. Dr. Allen has recently been appointed Assistant Professor of Botany of the University of Wisconsin. Dr. Robert A. Whittenberger had already left to join the staff of the Eastern Research Laboratory for work in connection with the Cryptostegia rubber program.

As at most larger institutions of learning throughout the country, the declaration of hostility was shortly followed at the University of Pennsylvania by the appearance of new groups of uniformed students accompanied by a demand upon university authorities for the prompt formulation of specialized and often entirely new programs of instruction. To Dr. John M. Fogg, Jr., Professor of Botany and from 1941 to 1944 Dean of the College of Arts and Sciences, came the responsibility for organizing and administering the Foreign Area and Language curricula for the Army Specialized Training Program.

The purpose of this curriculum was to instruct selected army trainees in the use of a foreign language, as well as to teach them a great deal about geography, natural resources, history, social, political economic and cultural institutions of the countries and peoples whose languages they were learning to speak. In addition to administering this program, Dr. Fogg also took some part in the instruction given the students. Since instruction included such unfamiliar languages as Moroccan Arabic, Hindustani, Bengali and Chinese, his own interests centered about teaching the students particular information concerning the native vegetation of such areas as French North Africa, India and China. Such instruction had to be of a somewhat practical nature since it was deemed important that the trainees learn something about agriculture and plants of economic importance. It involved explaining to them which plants were useful as food and drugs, which were poisonous and what types of vegetation might provide permanent or seasonal shelter for military purposes. It had to be borne in mind that in the case of a flier forced down in unfamiliar territory a knowledge of the natural resources might spell the difference between survival and disaster. Several hundred soldiers received instruction under this program during the two years of its duration. Dr. Fogg was appointed Vice-Provost of the University in 1944. In spite of increasing calls of an administrative nature upon his time he is glad to report that work on the new Flora of Pennsylvania still moves ahead and may shortly resume its former impetus toward completion.

During 1943 Professor Edgar T. Wherry gave a course in European Geography, and Professor Conway Zirkle one in inorganic chemistry to students in A.S.T.P. and other military personnel.

With so many members of the Department of Botany staff preoccupied with war-connected activities, unusually heavy teaching responsibilities were carried throughout the war period by Dr. Walter Steckbeck. These were further intensified by the accelerated program upon which the university operated during the war, in common with most universities.

It is with regret that we report the death in September, 1945, of Professor Irwin Boeshore at the age of sixty-two. Dr. Boeshore had been connected with the Department of Botany since 1913, first as graduate student and later as a

member of the staff. He took a deep interest in the rich collection of conifers at the Arboretum and made good use of them in connection with the courses on gymnosperms which he gave periodically. His other specialized interests, also upheld in advanced courses, were the ferns and their allies, and paleobotany.

Returning to the Arboretum, it is fortunately noted that staff changes have not been entirely in the nature of temporary or permanent losses. In May, 1943, the Arboretum welcomed the services of Percy W. Adams as Propagator. Mr. Adams was formerly superintendent at the Rose Valley Nurseries at Moylan, Penna. Mr. and Mrs. Adams now occupy the Millers House at Bloomfield Farm and we hope their association with the Arboretum will be long and pleasant.

The Arboretum was also fortunate in securing the assistance of George Campbell in October, 1943. Mr. Campbell is a machinist by profession and in addition to his other duties has already given yeoman service in the design and preparation of many hundreds of wooden and stainless steel labels for the outdoor collections.

The duties of Arboretum Secretary and Librarian were assumed by Mrs. Marion Code in January, 1944, after six months service as Executive Secretary of the Philadelphia Council for Conscientious Objectors in cooperation with Civilian Public Service under Selective Service. A graduate of Radcliffe College, she is experienced in secretarial work and fortunately possesses a refreshing interest in horticulture to sustain her through the rather deserted years of the war. Often she was the only occupant of the Administration Building which now begins to hum again with the activities of many workers.

Through these same years invaluable assistance was furnished by Nathaniel Watkins and William Streeper, both old friends of the Arboretum, yet both actively engaged for the first time in caring for the rose garden, the lawns and a host of attendant plant problems.

In this way the work of the Arboretum has gone on. While any expansion of activities was impossible under the circumstances, the enduring problems of maintenance were met and solved in a way which produced results comparing very favorably with similar situations throughout the country. This was accomplished in the almost total absence of customary additional summer help, thanks to the cooperation of the entire staff including, as yet unmentioned, three veterans of many seasons of rain, heat and snow at the Arboretum,—Andrew Falkenhagen, Joseph Costanzo and James Gillette. As a war note it may be further remarked that the tasks of John Tonkin and James O'Neill in directing this work were not lightened by the assumption of extra-curricular duties as air-raid wardens.

Besides such war cooperative efforts as have already been alluded to, a revision of normal procedures permitted participation in the Victory Garden program and production of a variety of farm and garden crops. The plowing of certain lawn and arable areas at Compton and Bloomfield Farm permitted the operation of some ten vegetable gardens by members of the Arboretum staff which have been continued into the present. In 1943 a sizeable demonstration victory garden was established under the direction of James Lambert in the vicinity of Macfarlane Hall at the Department of Botany. This garden served as a means of disseminating information to the general public and during one summer provided in addition creditable supplies of some thirty-five varieties of vegetables including 8 bushels of lettuce, 10 bushels of spinach, 250 pounds of tomatoes and 415 pounds of cabbage for the use of the University Hospital.

The wartime policy of the Arboretum in grazing cattle on the less highly developed portions of Compton and Bloomfield, in areas isolated by electric fences, had the triple purpose of lightening the burden of grass cutting, enriching the land, and supplementing the national supply of beef. This has been described in an earlier issue of *The Bulletin*. To date some 65,000 to 70,000 pounds of beef, comprising five herds of steers, have been produced by this means. A neighbor of the Arboretum, Mr. Gerald Buckler, manager of St. Joseph's Convent Farms, retains the responsibility of ownership and supervision of the cattle.



Fig. 20. A wartime scene in the Arboretum.

Through the summers of 1943 through 1945 the larger lawn areas of Compton were allowed to grow to hay as a means of alleviating the mowing problem, particularly acute in the shortage of gasoline. This also served, incidentally, to supplement the wartime needs of neighboring Pennsylvania farmers.

In spite of the demands of routine maintenance, gratifying progress was made in other directions. Under the expert guidance of Thomas Carney the water mill at Bloomfield underwent a complete mechanical overhauling in order to ensure continuation of its function of pumping water for Arboretum use. This renovation included removal and overhauling of the turbine and extensive repairs to the forebay as well as construction of a new mill-race dam with the necessary gates and screens.

Great strides have been made toward the solution of the problem of plant labels. Since this has involved the development of various new techniques which may well be of general interest, a detailed discussion of labelling methods will be reserved for a subsequent issue of *The Bulletin*.

It is also gratifying to report that through the continuing efforts of Dr. Schramm, the research project concerned with the vegetation reclamation of the wastes of the Pennsylvania anthracite region has been continued to the point where significant conclusions can now be drawn. The research has been conducted largely in the southern Pennsylvania anthracite region with the cooperation of the Philadelphia and Reading Coal and Iron Company, the State Department of Forests and Waters, and the U. S. Soil Conservation Service. On a basis of information secured through these experiments the Arboretum has been called upon in an advisory capacity in connection with pending legislation regarding the forestation of these wastes in Pennsylvania. It is expected that a part of the results of this work will shortly be published.

One further new development should be recorded. Since November, 1942, the Arboretum has provided office space and necessary facilities for a permanent tree nursery at Bloomfield Farm to further research in forest genetics in cooperation with the Northeastern Forest Experiment Station which has its headquarters in Philadelphia. This work is being carried on under the direction of Dr. Ernst J. Schreiner who also has charge of the Forest Research Station at Beltsville, Maryland. Fuller reference to this important project will be made in a later issue of *The Bulletin*.

In the library the war years were quiet but punctuated by a variety of demands for service. "Can you show me a picture of a Judas tree? I am an illustrator doing a child's alphabet book and need a Judas tree for J." "Where can I buy a Hottentot Fig?" "What shall I use for a hedge?" From our index of over 100 subjects from *acidity* to *hybridization* through *pollen allergy* to *wounds in trees* we are able to furnish reference reading to neighboring garden lovers, and from the pamphlet collection answer such questions from a patient in the Naval Hospital as "What shall I do for a repellent for deer on apple trees when I get back to my fruit farm?" On rainy days children sometimes beg for "Frontiers" or flower pictures. Students from the Dept. of Botany want materia medica if they are pre-vets. All sorts of questions,—and as the staff members return, the information service will become more prompt and authoritative.

Throughout the period covered by this summary the Arboretum has continued in its function as a welcomed place for both the education and relaxation of the general public. As a commentary, the advent of gasoline rationing brought contacts with a host of new visitors many of whom frankly admitted that they had not formerly realized that such trees and gardens existed in their midst. Numerous wounded service men from the nearby convalescent Rest House on Meadowbrook Lane have found pleasure and re-creation in frequent leisurely visits to our pleasant acres.

In conclusion, and since the above notes were written, the Arboretum is pleased to report the addition of another new member to the staff. As of January 1st, 1946, Margaret Anne Lancaster has assumed charge of the multiplying problems of plant location and landscape planning. Miss Lancaster, AB Wellesley, BS in Horticulture, Cornell, has had extensive practice in horticulture and landscape design at the Shipley Nursery, Towson, Maryland, the Flower Hill Nurseries at Ambler, Penna., and in the landscape offices of Fletcher Steele in Boston, Mass. She comes immediately from war industrial service with the I.T.E. Circuit Breaker Co. and the Electric Storage Battery Co. of Philadelphia. Miss Lancaster has a big job ahead but she is well qualified to handle it, and we wish her every success.

# Notes from the Laboratory

## Transplanting Depth for Red Pine

It is recognized that in the transplanting of any tree or shrub the more closely the former environment is simulated, the better the survival possibilities of the transplant. This note serves to call attention to the results of "too-deep" planting of red pine.

Several summers ago we had called to our attention a row of red pine on a local estate. In the original planting a row of forty young trees had been set up, but after some eight or ten years the close growing of these trees necessitated the removal of alternate individuals. The trees removed at this time had been dug up and replanted immediately in a continuous line with the originals. The first summer after transplanting all trees appeared to be in equally good health. The second summer the twenty moved trees showed signs of active degeneration. When brought to our attention the third summer after transplanting, each tree showed limited growth of current season wood, and all stages of aborted needle growth and yellowing and dying of tips. Excavating the root crown disclosed the fact that these trees had been planted from six to ten inches too deep. In some cases the stubs of the lower whorls of branches were under the ground.



Fig. 22. Root crown of one of the excavated red pines, showing the soil line before uncovering, the depth to the original soil line prior to planting-out in this location, and the two early stages of girdling roots.

The case histories of two specimens at the Arboretum which illustrate a situation similar to the foregoing are here presented. In the fall of 1936 two small trees of red pine were planted on the hillside just south of the Meadowbrook entrance. This part of the Arboretum has been designated the "pinetum" because of its environment suitable for conifer plantings. At the time of planting, the two red pines were about ten years old. Growth progressed well, and in the summer of 1938 the trees were considered to be in good condition and continued so through 1940. Early in the summer of 1941, following a spring which is remembered for its drastic effects on so many rhododendrons, signs of trouble were evidenced by retarded growth and dying of the tips of the two red pines. Late in July part of the root systems were excavated by washing. The trees were found to have been planted about eight inches below their former soil line. The root area from the trunk out to about three feet was a good fibrous appearing mass, but on examination it proved to be very poor in mycorhizal rootlets. This mass was almost entirely below the six inch depth. The outer portions of the roots, from three to seven feet from the trunk, were much less in quantity, but were nearer to the surface and had a fair portion of good mycorhizal rootlets.

By mid-September, symptoms were greatly intensified. Necrotic areas were prevalent in the trunk—from which no pathogenic organisms could be isolated. Many of the lower branches had died and had been removed. About seventy-five percent of the tips were dead and those living were aborted. The leaders had put on only about six inches of current season's growth,—in comparison to fifteen or eighteen inches in previous years. Soon after this the trees were removed.

It is quite probable that the same unusual weather condition in the early spring which caused the demise of the rhododendrons was a direct factor involved in the case of these pines. The fact that other young trees in this immediate locality were not affected vindicates the soil conditions in general. The fact that other red pines, --older and younger,—in the same area remained in good health reduces the probability that it

was a *specific* reaction. We know that in general the soil aeration is best in the upper horizon. We know, too, that the soil micro-organisms which are usually found in the upper horizon need oxygen. And finally we know that some of these micro-organisms are needed for the well-being of the tree in what we call the mycorhizal complex. Therefore when the roots are placed too deep in transplanting the normal mycorhizal complex can be neither maintained nor built up. Thus the tree becomes weakened and falls a victim to such climatic disturbances as were experienced in the spring of 1941.

Figure 22, in addition to showing the depth of planting, demonstrates what may occur if the roots are not properly laid out at the time of transplanting. The two white pointers mark the early stages of girdling roots. In later years, had this tree survived, the growth of these roots might well have caused the strangulation of the parts they are now encircling.

SPENCER H. DAVIS, JR.

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## Seed Release In Atlas Cedar

Figure 21 illustrates a phenomenon of rather unusual interest which was observed for the first time at the Morris Arboretum in 1943,—the natural seed shedding of *Cedrus atlantica*. The production of cones by any one of the true cedars (*Cedrus libani, atlantica* or *Deodara* is scarcely a common sight in the United States for trees must apparently approach the age of 40 years or more before they bear at all heavily; then again the cones normally require two to three years to ripen before suddenly shattering under the influence of rather special weather conditions. Two trees have fruited at the Morris Arboretum for several years, but too numerous squirrels, among their other depredations, seldom permit the cones to remain long enough to become fully ripe.

The cones illustrated developed from flowers which were pollinated during the Fall of 1940. At first purplish in color, they became an attractive grey green and attained about two thirds of their normal size during the summer of 1941. Growth was completed during 1942 and towards the end of the year they became brownish but were still hard and remained very firmly attached. The weather was continuously dull and cold during much of December 1942 and early January, 1943, but a brief warmer period, accompanied by light rains alternating with bright sunlight, commenced Jan. 12. By Jan. 14 the ground beneath the largest *Cedrus atlantica* was covered with scales and seeds. The stiff, woody scales had suddenly loosened so that the cones shattered at a touch, to leave only their hard



FIG. 21. Seeds and partially shattered cones of *Cedrus atlantica*.

central axes attached, candle like, to the branches. Abundant large seeds from the central third of each cone contained nine or ten well-developed cotyledons, and such seeds, sown in the greenhouse a few days later, showed excellent germination within a month. During 1945 cones were borne on *Cedrus atlantica* as well as on the varieties *aurea* and *glauca*. This year the cones shattered a full month earlier,—the second week in December. At this time, in May, abundant seedlings are showing beneath the tree.

It has been generally observed that the Deodar requires about the same time to ripen its fruits as the species described, whereas the Cedar of Lebanon takes from nine months to a year longer. Cones of all three species remain very hard if gathered and dried before they are fully mature. In this condition those of *C. libani* are especially difficult to open. To obtain seeds from such cones Loudon's suggestion* of half a century ago is still worth following—store the cones for some time after gathering (up to a year will not be harmful to the seed), then soak them for a day or two in water, after which they can be split apart by driving a conical spike through the axis. It is not easy to obtain whole seeds by attempting to break them in a dry condition.

HENRY T. SKINNER.

* J. C. Loudon. TREES AND SHRUBS OF GREAT BRITAIN. London, 1883, p. 1059.

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# Morris Arboretum Bulletin

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FIG. 23. *PAGODA TREE.*
*Sophora japonica L.*

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# Pagoda Tree

A source of continuous admiration at the Morris Arboretum is the large rounded mass of a Japanese Pagoda Tree which stands near the main gate on Meadowbrook Avenue. Two other reasonably good specimens exist in the arboretum but while one of these has considerably larger and more imposing flower clusters, neither has yet attained such fine proportions as the one pictured on the cover. This particular tree is at present 57 feet high, with a spread of 70 feet and trunk diameter of 36 inches.

The Pagoda Tree, *Sophora japonica,* is interesting in several respects. In the first place it suffers from a misnomer. It is usually referred to as the *Japanese* Pagoda Tree. While it is true that this tree is frequently met as a planted specimen in Japan it seems indigenous, nevertheless, only to China where it occurs over a very large area. The alternative name of Chinese Scholar Tree might be more suitable were it not for the fact that the "pagoda" angle now seems rather firmly entrenched in our western literature. Because it flowers late and these flowers seem to offer the last welcome stamping ground for Japanese beetles it is sometimes, here in Chestnut Hill, referred to as the Japanese Beetle Tree,—but that is neither here nor there. The blossoms at this time of the year, in August and early September, are fortunately so plentiful that the few remaining beetles have a difficult task indeed to make more than a very poor showing in their depredations. It is bothered by little else in the way of insects or diseases.

*Sophora japonica,* along with Black Locust, Yellowood and Kentucky Coffee Tree, is one of the relatively few tree members of *Leguminosae,* the pea family. It has the typical pinnate or divided leaves and pea-like flowers (see Figure 24). In the United States the flowers are usually pale yellowish in color. This is evidently the commonest form although it has been noted that forms with pure white flowers are to be found in Central China, and others, bright yellow in color, in the vicinity of Canton. Like certain other members of the pea family the leaflets of the Pagoda Tree have a tendency to partially fold together at night, and it is interesting that an observation of such leaf movement was recorded in Erh-ya, a Chinese dictionary, in the 12th Century B.C. The Pagoda Tree must have been one of the first subjects for a botanical observation of this nature! Throughout Chinese history it has played a part in the ceremonies of official audiences while its flowers have been used to produce a yellow dye and its pods for medicine. Cultivation in Europe

(*continued on page 52*)

# Men and Nut Trees

## AN OPEN LETTER TO THE MANAGERS OF ARBORETA

By Dr. J. Russell Smith

*Professor Emeritus of Economic Geography, Columbia University*

The anthropologists are continually revising and raising their estimates as to the duration of the period during which man has been using tools. Five hundred thousand years is now a fairly common estimate. For nearly all of this time man lived in what we commonly call the Stone Age. For the last few years, say 2% of the time, men (some of them) have been farmers. During the major part of the half million years, say 98%, or something like 490,000 years, our ancestors depended upon wild products for their food. If it was digestible they ate it—beast, bird, insect, fish, fowl, egg, grub, root, branch, nut husk, leaf, flower—just so it was digestible.

During this long period nut trees played a very important role in the support of men in the temperate latitudes. Hickory nut, walnut, beechnut, filbert, hazelnut and pine nut were standard articles of food, but especially the acorn.

The American Indian is reported to have pounded up hickory nuts, shells and all, and boiled the whole mass. The high percentage of fat floated on the top as a creamy layer to be skimmed off and used as butter with the corn meal and acorn products. The walnut with its high protein was both meat and rival to the marrow, which was a great delicacy with the primitive man. It was his closest approach to ice cream. Anthropologists have recently discovered and identified in eastern Germany an earthenware vessel filled with beechnut butter at least 2,000 years old.

The acorn seems to have been the King of nuts for a few hundred thousand years of the Stone Age and the oak has probably outranked all the other nut trees combined in its services to primitive man. There are many species; they have wide distribution, and acorns have excellent keeping qualities. Their high food value is shown by the table on page 48.

Perhaps you say that acorns are bitter. True, most of them are. They are bitter with tannin, soluble in water. This fact was discovered ages ago. The primitive woman cracked up the acorn meats, leached them in water and, behold, the bitter things became sweet.*

* See page 152 "Tree Crops," J. Russell Smith, Walnut Lane Press, Swarthmore, Penna. for an account of making acorn bread by the experimenters of the Missouri Botanical Garden.

John Muir, the famous California naturalist, did much mountain climbing, often living in the open for days. As described in The National Geographic Magazine, August, 1918, he carried a small pack and lived on acorn bread made by the local Indian recipe. He claimed, furthermore, that nothing the white man had was equal to it.

Wheat has been an agricultural product for the last 10,000 years, but during this time it has been a staple food of only two of the four major groups of humans. It is entirely possible that in the hundreds of thousands of years of the pre-agricultural period man ate more of acorns than he has ever eaten of wheat. Perhaps the old adage that history repeats itself will be repeated with the nut trees. They may return as great staples in human sustenance and there are several reasons to suggest this possibility.

1. *The new scientific basis of crop selection.* All our important crops—wheat, corn, barley, rye, oats, rice, sweet potato, white potato,—are annuals which were domesticated by the primitive man (probably woman) in the undated past. Surely we are now in a position to do better than these primeval, unlettered opportunists! Scientific botany is beginning to test plants, not for their *annual* possibilities but for their *total* possibilities. In this connection the tree shows itself as the great natural engine of production. Certain wild oak trees have been known to yield a ton of acorns at a crop. Walnut trees yield many bushels. These are but samples.

2. *The new horticultural process.* In the recent past the horticultural process has consisted largely of finding one good wild tree, a chanceling, and propagating it by grafting or budding. Thus we have millions of navel orange trees grown from one chance freak of nature. By this process came nearly all the apple trees in our orchards, nearly all peach trees, plum trees and cherry trees.

We now have *plant breeding.* As a scientific practice plant breeding is a very new thing, dependent as it is upon the so-called Mendelian law, first put to work in this century. By applying modern methods of plant breeding we may change agriculture as high-speed steel has changed the machine shop and given us cheaper auto-

mobiles and other machinery. New vistas in agricultural production open before us as we consider the use of plant breeding applied to the very effective wild trees to produce much better trees. We have here the possibility of a whole new series of crops that grow on trees rather than on straw and corn stalks. Such a new principle may increase the yields per acre, but there is a much more important aspect. If we think of ourselves as part of the human race, it offers the possibility of agriculture without soil destruction, that is,—*permanent agriculture.*

The United States has one of the finest blocks of farm land in the world. Our corn belt is without a rival but how long will it last? I recommend the reading of a bulletin from the Soil Conservation Service, Washington, D. C. giving the latest estimate of soil destruction by erosion in the United States. Consider its facts, and the probable future of our country makes one shiver. In the short period since some of the readers of this article were born we have destroyed more land, twice over, than the Japanese people were using in 1943 to support themselves as a world menace. Japan is cropping about 15 million acres, we have destroyed about 50 million,—a large part of it within 50 years,—and we partly destroyed several times as much more.

We are so destructive because we are unintelligent transplanters of European agriculture. We brought with us European agriculture which is the agriculture of wheat, barley, rye, oats and clover—plants which cover the ground. We added to them in America corn,, cotton and tobacco. plants which have row culture and cultivation between the plants. We came from North Europe where rains are gentle to America where we have the torrential thunderstorm. The fields of corn, cotton and tobacco, repeatedly cultivated during the summer, are repeatedly ripped by the rushing gully waters of the thunderstorm. Hence this appalling destruction and hence the new possible importance of nut-bearing trees as savers of America.

We are now using millions of dollars worth of English walnuts, Brazil nuts, filberts, hazel nuts, cashews, cocoanuts. We should look forward to the early date when acorn bread would be as easily obtained as a loaf of wheat bread, and like the wheat bread made in a factory. This means that we need to have first a search of the whole Temperate Zone for the most productive specimens of oak trees, selective breeding within the species, hybridization between the species, and testing of tens of thousands of these scientifically bred plants each year.

At the present time we Americans are still cutting down natural forest on the Appalachian

## *AVERAGE COMPOSITION OF NUTS AND OTHER FOODS

| Kind of Food | Refuse | Edible Portion | | | | | | | Fuel value per lb. |
|---|---|---|---|---|---|---|---|---|---|
| | | Water | Protein | Fat | Carbohydrates: Sugar, Starch, etc. | | Crude Fiber | Ash | |
| Nuts and Nut Products: | % | % | % | % | % | combined % | % | % | calories |
| Acorn, fresh | 17.80 | 34.7 | 4.4 | 4.7 | 50.4 | | 4.2 | 1.6 | 1,265 |
| Filbert | 52.08 | 5.4 | 16.5 | 64.0 | | 11.7 | | 2.4 | 3,100 |
| Hickory Nut | 62.20 | 3.7 | 15.4 | 67.4 | | 11.4 | | 2.1 | 3,345 |
| Pecan | 50.10 | 3.4 | 12.1 | 70.7 | 8.5 | | 3.7 | 1.6 | 3,300 |
| Walnut (Persian) | 58.80 | 3.4 | 18.2 | 60.7 | 13.7 | | 2.3 | 1.7 | 3,075 |
| Walnut (American Black) | 74.1 | 2.5 | 27.6 | 56.3 | | 11.7 | | 1.9 | 3,105 |
| Meat, Round Steak | | 65.5 | 19.8 | 13.6 | | | | 1.1 | 950 |
| Wheat Flour, high grade | | 12.0 | 11.4 | 1.0 | 74.8 | | .3 | .5 | 1,650 |
| White Bread | | 35.3 | 9.2 | 1.3 | 52.6 | | .5 | 1.1 | 1,215 |
| Beans, dried | | 12.6 | 22.5 | 1.8 | 55.2 | | 4.4 | 3.5 | 1,605 |
| Potatoes | 20.00 | 78.3 | 2.2 | .1 | 18.0 | | .4 | 1.0 | 385 |
| **Corn meal | | 12.5 | 9.2 | 1.9 | | 74.4 | 1.0 | 1.0 | |
| **Wheat flour | | 11.5 | 11.4 | 1.0 | | 75.4 | .2 | .5 | |
| **Leached acorn | | 11.3 | 4.5 | 19.8 | | 62.0 | 2.1 | 2.9 | |

* Unless otherwise stated, from "Nuts and their uses as food" by M. E. Jaffa, Professor of Nutrition, University of California, U. S. Dept. Agr. Farmers' Bulletin, No. 332, reproduced in "Tree Crops" (p. 304) by J. Russell Smith, Walnut Lane Press, Swarthmore,, Pa.

** Figures from C. Hart Merriam, National Geographical Magazine, Aug. 1918.
In studying the column marked "refuse" it should be remembered that some of the nuts tested were the poor, wild produce of the present markets rather than from such selected and improved strains as can be grown.

mountainsides and then proceeding to ruin these mountainsides with 3 to 10 crops of corn. There is no reason why such hillsides, with the proper kind of oak trees, should not yield each year for centuries more carbohydrate food than they do now in each of the few crops of corn that come between clearing and ruin by gully. If this sounds a little pipe-dreamy, it is only because we haven't applied scientific imagination to the materials now in hand. There are such mountainsides in Corsica, Italy, France, the Balkans and Spain that have been yielding similar crops of chestnuts for many centuries with no appreciable soil loss. There was no soil loss because there was no tillage, and there was enough undergrowth and leaf and twig waste to maintain fertility and prevent erosion. It may be mentioned that the Chinese chestnut now holds out the easy possibility of chestnut orchards on American hillsides like those that have existed in Europe for the last few centuries.

This article is written as an appeal to the managers of arboreta to select and breed oak trees as indicated above. Many arboreta have done valuable work in gathering together collections of specimens of trees, keeping the trees alive and putting labels on them, but that is not enough.

Some one will say—let the government do it, but past experience has shown that government workers are unfortunately both dependent upon and handicapped by frequent changes of administration, intermittent appropriations, and the mercies of budget makers who too frequently lack any understanding of basic agricultural concepts. A few attempts have been made but the output of government-sponsored research in a field of such fundamental economic importance as tree breeding has been pathetically small. If any one is inclined to doubt that I suggest a check-up on what the United States Government and those of the 48 states have done to select and breed the following very productive wild trees of the United States: Black Walnut, Butternut, Pecan, Shagbark, Shellbark, Pine Nut, Hazel Nut, Beech, Persimmon, Pawpaw, Haw, Wild Plum, Wild Cherry.

An arboretum in private hands can have continuity and I hope that some such arboretum may give a world service and create a world reputation by applying Mendel's Law to the genus *Quercus* with scientific imagination.

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# Forest Genetics Research at the Arboretum

Under various Acts of Congress, the Forest Service of the United States Department of Agriculture set up Forest Experiment Stations in the principal forest regions of the United States. One of these, the Allegheny Forest Experiment Station, charged with conducting research in the problems presented by the forests and woodlands of Pennsylvania, New Jersey, Delaware and Maryland, was established in 1926 with headquarters in Philadelphia, in cooperation with the University of Pennsylvania. From the beginning and until recently the offices of this Station were located on the campus of the University. When in 1941 the Regional Forester's office (in charge of state and private cooperative activities and of the national forests of the Northeastern United States) was moved from Washington, D. C., to Philadelphia, the office of the Allegheny Station was joined with that of the Regional Forester in downtown Philadelphia. The close relation with the university continues, especially with its Department of Botany where until fairly recently the Allegheny Station, in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture, maintained a laboratory for the investigation of tree diseases.

Curtailment by Congress of funds for forest research with the approach of war led the U. S. Forest Service in 1941 to close the Northeastern Forest Experiment Station at New Haven, Conn., transferring the administration of certain selected research activities of that section to the Allegheny Station in Philadelphia.

Among these was the Forest Genetics Project concerned with the production, through hybridization and selection, of improved races and strains of forest trees for general forest or more specialized purposes. Since the immediate availability of a wide variety of native and exotic tree species of flowering and fruiting age is important for the successful prosecution of this work, especially that concerned with hybridization, the Allegheny Station surveyed its territory including Washington, D. C., for possible headquarters for the forest genetics work. The choice fell upon the Morris Arboretum which was happy to extend its facilities to the Allegheny Forest Experiment Station.

Dr. Ernst J. Schreiner is in charge of the work. The Arboretum has provided office and laboratory space in the administration building. On the fertile Hagerstown loam soil of the Arboretum's Bloomfield Farm land has been made available on which Dr. Schreiner and his staff have established nurseries for current experimental work and for maintaining stocks. For certain aspects of the work space and facilities are available in Arboretum greenhouses.

Since this work commenced, the Allegheny Station in Philadelphia has been renamed the Northeastern Forest Experiment Station. In September of last year Dr. Schreiner was also given charge of the Beltsville Work Center of the Northeastern Station at Laurel, Maryland. The Morris Arboretum project, however, remains under his supervision although it is now carried forward under the immediate direction of Dr. Jonathan W. Wright who was appointed to the staff of the Northeastern Forest Experiment Station in July of this year. Dr. Wright was formerly in the Department of Forestry at Purdue University.

Through this association the rich Arboretum collections of living woody plants serve additional ends through their utilization in the little explored but assuredly important field of developing new improved races of trees and shrubs for forest and other more specialized uses in the broad field of conservation.

J.R.S.

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# Notes From the Library

The library now contains approximately 2200 volumes dealing with many angles of the complicated subject of Botany. There are works on flora of different parts of the world, agricultural information, books on ecology, mycology and genetics, as well as bound journals of botanic gardens and horticultural magazines, volumes on landscape architecture, historic gardens and specialized subjects in the various fields. This library contains also some valuable old volumes from the Bartram collection and although not complete in any one field, taken together with the Department library it forms a fairly adequate reference source for diversified plant information.

Library hours at the Arboretum are from 9 to 12 and 1 to 5 Mondays through Fridays. The library is in charge of the Arboretum Secretary who works in cooperation with Miss Mary Newkirk, Librarian for the Department of Botany.

Among books acquired since 1942 are the following titles:

AN AGRICULTURAL TESTAMENT—Sir Albert Howard, Agricultural Adviser (Oxford Press, 1940)

CAMOUFLAGE WITH PLANTING—Ralph Rodney Rood (Chicago, R. F. Seymour, 1942)

CEANOTHUS—Maunsell van Rensselaer (Santa Barbara) Botanical Garden, 1942)

CHEMISTRY OF INSECTICIDES AND FUNGICIDES—D. E. H. Frear (Van Nostrand Co., 1942)

CONSERVATION OF NATURAL RESOURCES, Morris Arboretum Monograph No. 2—Univ. of Penna. Bicentennial Conference (University Press, 1941)

DWARF AND SLOW GROWING CONIFERS. 2nd Ed. Murray Hornibrook (C. Scribner's Sons, 1938)

FOREST FLORA OF JAPAN—Charles Sprague Sargent (Houghton, Mifflin & Co., 1894)

FOREST TREE SEED—H. I. Baldwin (Chronica Botanica, 1942))

THE FRIENDLY EVERGREENS, L. L. Kumlien (D. Hill Nursery Co., Dundee, Ill. 1946)

GARDENING, A COMPLETE GUIDE TO GARDEN MAKING—Montague Free (Harcourt Brace Co., 1937)

GARDENING WITH THE EXPERTS—By noted authorities (Macmillan Co., 1942)

GUIDE TO THE MUSHROOMS OF NEW YORK—Louis C. C. Krieger, Mycologist N. Y. State Museum (Univ. of N. Y. Press, 1935)

HERBS, THEIR CULTURE AND USES—Rosetta E. Clarkson (Macmillan Co., 1942)

IF I WERE TO MAKE A GARDEN—E. H. Wilson (Stratford Co. Boston, Mass. 1931)

ILLUSTRATED FLORA OF THE PACIFIC STATES—Leroy Abrams (Stanford Univ. Press, Calif. 1944)

MAINTENANCE OF SHADE AND ORNAMENTAL TREES—P. P. Pirone (Oxford Press, N. Y. 1941)

MANUAL OF MUNICIPAL AND COUNTY PARKS—Edited by L. H. Weir (Barnes, N. Y.)

MODERN FRUIT PRODUCTION—J. H. Gourley and F. S. Howlett (Macmillan Co., 1942)

MORE ARISTOCRATS OF THE GARDEN—E. H. Wilson (Stratford Co., 1930)

ORNAMENTAL AMERICAN SHRUBS—W. R. Van Dersal (Oxford Univ. Press, 1942)

PLANTS IN THE HOME—Frank K. Balthis (Macmillan Co., 1942)

POISONOUS PLANTS—Walter C. Muenscher (Macmillan Co., 1939)

PRUNING TREES AND SHRUBS—Ephraim Porter Felt (Orange Judd Co., Inc. 1941)

PLOWMAN'S FOLLY—Edward H. Faulkner (Univ. of Okla. Press, 1943)

ROCKY MOUNTAIN TREES—Richard J. Preston, Jr. (Iowa State College Press, 1940)

SHRUBS AND TREES FOR THE SMALL PLACE—P. J. Van Melle (C. Scribner's Sons, 1943)

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THE FOOD GARDEN—Lawrence and Edna Blair (Macmillan Co., 1942)

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TIMBERS OF THE NEW WORLD—S. J. Record and R. W. Hess (Yale Univ. Press, 1942)

TREES AND SHRUBS OF BRITAIN – J. C. Loudon (Longmans, Green and Co., 1869)

TREES AND SHRUBS FOR PACIFIC NORTHWEST GARDENS—John and Carol Grant (Dogwood Press, Seattle, 1943)

WEEDS OF LAWN AND GARDEN—A Handbook for Eastern Temperate North America. By John M. Fogg, Jr. University of Pennsylvania Press.

The Library has been enriched this summer by a variety of gifts. From Mr. Albert F. Meehan of Dresher, Penna. come four volumes of THE HORTICULTURAL ART JOURNAL of 1886 through 1889, published by the Stecher Lithographic Company of Rochester, New York. Within the calf-trimmed marbeled boards the "Publisher's Card" reads: "The pages of this Monthly Journal will be devoted to disseminating a correct and faithful representation by means of colored lithograph plates made from nature by skilful artists of the new and meritorious productions of the Nursery, Seed Garden and Green House." Most of the plates are richly colored and the text contains scientific notes and data of interest to historians of horticulture in America. A Directory Supplement lists the chief nurseries of the period in 7 states from New York to Wisconsin. These volumes from the Library of Mr. Meehan's grandfather, Thomas Meehan of Germantown, will serve as a valuable reference source for the origins of numerous early horticultural varieties. Such information is often very hard to find.

Another friend and associate of the Arboretum, Mrs. E. Florens Rivinus, brought us three most interesting contributions. First a piece of inlay made by Indians in Mexico, about 18 x 14 inches square inside a carved frame. It represents an Indian girl on horseback in the desert, and every scrap of the picture, down to the coil of the lariat on the saddle horn, is made of native Mexican woods cut and fitted with skilful craftsmanship. The colors are harmonious and the whole effect unusually vivid for this type of work. It now adorns the library wall above the secretary's desk.

The two weighty volumes of the Monograph on the *Genus Rosa* by Ellen Wilmott, with drawings by Alfred Parsons R.A. (London, 1914) comprise the second gift from the Rivinus library. This, the best known reference source on roses, is a valuable work whose beautifully colored plates will bring Oh's and Ah's from rose-loving visitors during the long months when the rose gardens are bare of bloom.

An especially prized addition is an ancient, enormous and excellently preserved volume of RIVINI INTRODUCTIO GENERALIS IN REM HERBARIAM, (1690 edition), an heirloom in the Rivinus family. Concerning the work and its author Dr. John M. Fogg makes the following comments:

"Augustus Quirinus Bachmann (1652-1725) was for many years Professor of Botany, Physiology, Materia Medica and Chemistry at the University of Leipsic. Following the practice of many scholars of his day, Bachman latinized his name and wrote under the non de plume of Rivinus. His magnum opus, published in 1690 under the title "Introductio generalis in rem herbariam" gives the author's theories on plant relationships and elucidates the principles to be followed with respect to the naming of genera and species. Rivinus advocated the practice of allotting a generic and a specific name to each kind of plant and in a sense anticipated the principle of binomial nomenclature later crystalized by Bauhin and Tournefort. He was one of the first botanists to reject the traditional classification of plants into trees, shrubs and herbs,—a classification which had been popularized by Aristotle and slavishly followed by students for nearly 2,000 years. Linnaeus later acknowledged the pioneering efforts of the author of the "Introductio."

"A great English contemporary, John Ray, writing of this work a few years after its appearance says: 'I emphatically recommend Rivinus' work for its careful notes on floral differences, for its ingenious analysis of them as a basis for classification, for its beauty and clarity, its purity of Latin, its elegant plates. But the learned author will forgive me if, as is the way of mankind, I am too partial to my own system and think it more congruous to the nature of plant-life than his.' Although Rivinus was more interested in nomenclature than in structure as a basis of plant relationships, his position in the history of botany is secure and his *Introductio* is an important milestone. The copper plates,—which number approximately 500,—are believed to have cost the author in the neighborhood of 80,000 florins."

A quaint flavor of the time emerges from the Latin preface: "If Botanic study has ever flourished truly it thrives as much as possible in these times, when not only medical men but all who have at heart the most joyous science of nature put so much industry in the examination of plants that commonly he who may be caught wholly inexperienced in this matter does not know how to bear himself in the company of amateurs, to say nothing of learned men."

M.C.

## Weeds of Lawn and Garden

*A Handbook for Eastern Temperate North America*

by John M. Fogg, Jr.

Friends of the Morris Arboretum will be especially interested in the above contribution by Dr. Fogg, recently published by the University of Pennsylvania Press with the aid of the Arboretum. In a compact space of some 215 pages, Dr. Fogg gives the kind of information which should prove extremely useful to everyone who owns a garden and for whom the problem of weeds has not yet been entirely solved.

The notable feature of this book is the clearly reproduced illustration in the upper half of each page representing the species under consideration. No keys are found in this work but 189 species can be readily identified by comparison with the figures. In most cases the entire plant is shown in flower and fruit together with its root system. Where the species is unrecognizably different in its juvenile stage (when it is easiest to eradicate) this stage is shown. The latter is helpful to novice and experienced gardener alike, especially during the early growing season when the wrong plant may be destroyed or allowed to grow because of uncertainty. Each illustration is identified by common and scientific names, habitat of the species and its life span. In addition to the common run of weeds, several pages at the end of the book show what eight of the more common tree "weedlings" look like when they invade lawns and gardens.

The remainder of each page is devoted to information about the flowers and seed, habit, distribution and other characteristics helpful in establishing the weed's identity. Extermination methods are suggested under each species in addition to the chapter entitled "Chemical Control," both of which should be useful to the practical gardener.

In the introduction the author discusses fully the subjects: What is a weed? Why some plants are weeds; Dispersal of weeds; Geographical origin of weeds, and Weeds as soil indicators. There is a glossary of terms used in describing the weeds themselves, a bibliography for those interested in the further study of these plants and a complete index.



Fig. 21. Flower clusters of *Sophora japonica*.

The handy pocket size and waterproof binding enable one to use this manual in garden or field without risk of spoiling the cover from dew or ground moisture, and although non-technical in character the accuracy of the drawings and descriptive material make this work useful to layman and professional alike.

J.W.A.

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## Pagoda Tree

(*continued from page 46*)

dates from 1747 when it was sent to France by the Jesuit missionary Pere d'Incarville.

*Sophora japonica* is characterized by very smooth dark green twigs which have naked and densely hairy violet brownish buds. Its leaves have a fresh and rather distinctive bright green color and are carried very late into October. The flower clusters mature to pods which are usually constricted between each seed giving the curious effect of numerous pendant beadstrings. In the eastern United States the Pagoda Tree forms a quite beautiful and relatively broad and rounded mass supported by one or several main trunks. It is longlived and ages well. Its all year appearance combined with late season flowering and general pest resistance make it a fit subject for far wider usage in home ground and park planting than it has so far been accorded.

H.T.S.

GRAY HERBARIUM
FEB 19 1947
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# Morris Arboretum Bulletin

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FIG. 25—COLUMNAR SWISS STONE PINE.
*Pinus Cembra columnaris* Beiss.

Photo by Gustave Liebscher

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# The Columnar Swiss Stone Pine

The Swiss Stone Pine, *Pinus Cembra,* is a five-needled pine native to the Swiss Alps and, in its variety *sibirica,* to northeastern Russia and Siberia. In its native haunts it makes a tall tree becoming relatively broad and often round-topped with age. The freely produced cones of this tree are 2 to 3 inches long but they never open. Their edible seeds seem to be scattered in nature purely through the agency of squirrels, mice and other animals who break the scales off the cones and carry the seeds to their often distant hoards. Since squirrels seem to have short memories for the location of some of their storehouses, a number of these seeds will escape further attention until they eventually develop into scattered stands of new pine trees. The wood of this species is relatively fine-grained and durable as well as being soft and easy to work. It is much used by the Swiss for the manufacture of toys, earrings and a variety of hand-carved objects.

In the Eastern United States the Swiss Stone Pine, although distinctly slow-growing, is a highly desirable species for ornamental use; it is usually pyramidal in shape and very compact. Furthermore, it seems to thrive in exposed positions on quite poor soils. A specimen of the type species to be seen at the Arboretum has been previously figured in the Bulletin on page 101 of Vol. 1, No. 8.

The subject of this note is the columnar variety of this pine, *Pinus Cembra columnaris,* a horticultural variant which, at least in this climate, seems to attain its height more rapidly than the species but which at the same time, as may be seen in Fig. 25, is much narrower in habit. One of three similar trees at the Morris Arboretum, the specimen illustrated has attained a height of 30 feet with a spread of only 7 feet 6 inches at an age of approximately 36 years. Although this columnar form has been cultivated for a considerable number of years in continental Europe and the United States it is nevertheless still comparatively rare. By the absence of references to this form in the best known reference works from England, one is led to believe that, rather surprisingly, it is not likely to be met in the gardens of that country.

Where space is limited, or where design calls for the employment of an arresting vertical of relatively coarse texture, here is a subject which can be recommended for addition to our present rather limited bill of fare in this category. At present it does not, unfortunately, seem to be available in commercial nurseries.

H.T.S.

# Lignum-Vitae at the Arboretum Mill

Without lubrication, an under-water Lignum-vitae bearing carrying the full weight of a 2-ton spinning water-power turbine has completed thirty years of uninterrupted service at the Arboretum. And it is still in excellent condition, capable, if called upon, to perform for many more years its gruelling task. That no metal or other material has ever been found or developed which under these severe conditions approaches in practical performance this remarkable natural wood is perhaps not generally known. A brief account may therefore be of interest.

The trees yielding this wood belong to the genus *Guaiacum* of the Zygophyllaceae (Caltrop family). The genus is represented on all West Indian islands, the northern coastal regions of Colombia and Venezuela, the western fringe of Central America and Mexico, and the southern shores of the Gulf of Mexico. One species occurs in the United States, *Guaiacum sanctum,* on some of the keys off southern Florida. *G. officinale* has been the preferred source of Lignum-vitae, although *G. sanctum* also enters commerce considerably. More recently other species, too, have assumed commercial importance, especially *G. guatemalense.*

Besides being very hard and heavy (the dry wood sinks in water like a stone), the wood is very durable. But it is not to these properties that it owes its name — the wood of life — but rather to its supposed extraordinary medicinal powers. Soon after the discovery of America, stories of its healing virtues heard from the natives of Santo Domingo were carried back to Spain and early came to the notice of the European medical profession. Lignum-vitae gained great prestige as a specific for many diseases, notably syphilis, and a very considerable literature developed concerning it. At the height of its vogue the wood sold for fantastic prices, so great was the medical demand for it.

In this connection it should be pointed out that the heartwood contains a colored resin (Guaiac) which on exposure to air (oxidation) undergoes a striking color change. It is not to be wondered at that unusual virtues and powers should have been attributed to a wood possessing such apparently mysterious properties. However, both the wood and the resin have long since lost all standing in legitimate medicine. But the reputation of Lignum-vitae as a wood is secure and growing.

Blackish with a greenish tinge, it is one of the hardest woods known. Besides, the fibers run obliquely both radially and tangentially in such fashion that it all but defies splitting. But these properties, very important as they are, do not alone account for the unmatched performance of Lignum-vitae when used for under-water bearings. The capstone is supplied by the abundantly contained resin which acts as a lubricant. In short, the wood is self-lubricating.

Lignum-vitae, because of its hardness, great strength, and tenacity, finds very successful use in such hard-service articles as pulleys, bowling balls, caster wheels, mallets, etc. But its most important use by far, and the one calling for the greatest endurance, is as bearings for the great propeller shafts in steamships, including giant liners and battleships. Record and Hess in their




Fig. 26. Inscription on newly inserted penstock timber at the Water Mill.



Fig. 27. Bottom iron support of turbine assembly showing portions of the four radiating arms. The mushroom-like disk in the center is the top of the Lignum-vitae bearing. The concentric striations are shallow grooves worn by the cup-like iron bearing attached to the bottom of the revolving turbine and engaging the wood bearing. The base of the Lignum-vitae bearing (not visible) is tapered and wedged firmly into a correspondingly tapered socket in the center of the iron support.

recent book* state that "steel and tube mills are using Lignum-vitae in increasing amounts to replace brass and babbit metal for bearings in roller mills and pumps as the initial cost is less than that of metal, the life is several times as long and lubrication is unnecessary."

Opportunity to inspect this Lignum-vitae bearing was presented when in 1943 the water turbine at the mill on Wissahickon Creek was overhauled. The hydraulic engineer pronounced the bearing good for many more years of service; but since it had worn down somewhat it was decided to replace it with a new full-length Lignum-vitae bearing. The general overhauling made this replacement a simple operation. The veteran now enjoys a richly merited pensioning in the Arboretum's collections.

On the occasion of reconditioning the turbine, all the wood installations in the mill-race and penstock were replaced. These, built about twenty years ago out of long-leaf, or Southern yellow, pine (*Pinus palustris*), had rotted and deteriorated to the point of uselessness. The replacements are constructed throughout of the heartwood of bald or southern cypress (*Taxodium distichum*) from northern coastal Florida. This choice grade of all-heart cypress was obtained from the J. Gibson McIlvain Co. of Philadelphia, well known dealers in southern cypress lumber. The courtesy of the firm in permitting the Arboretum to select the individual timbers used is gratefully acknowledged.

The scope of the construction and the considerations which led to the choice of bald cypress will be apparent from the accompanying photograph of the inscription on one of the constituent cypress beams at the upper end of the penstock or forebay (Fig. 26). The exacting construction work was skilfully carried out by the men of the Arboretum. As a result the water power installation which furnishes much of the water used in the Arboretum is again in excellent operating condition and should remain so for many years to come.

J. R. Schramm

* Record, Samuel J., and Hess, Robert W. TIMBERS OF THE NEW WORLD. Yale Univ. Press, 1943.

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# Plant Accessions of 1946

Living plant collections at the Morris Arboretum have been enriched by the acquisition of some particularly interesting plants and plant groups during the past season. From Mr. C. F. Jenkins we were pleased to receive several varieties of his favorite native hemlock including a splendid 10-foot specimen of the variety *compacta*. All of these are being used as fine background material in the new evergreen plantings surrounding the rose garden. Such plantings include predominantly boxwoods on the upper end and mixed groupings of Cephalotaxus and yews down either side. With the addition of 7 more varieties of boxwood from Swarthmore College, Princeton University, and Cornell University, as well as a set of 19 named forms from Hillier and Sons of England, the Arboretum collection in this genus becomes perhaps one of the most complete in this section of the country.

*Rhododendrons and Azaleas.* Late last season 25 plants of some of the best strains of the late Mr. C. O. Dexter's Fortunei hybrid rhododendrons were received from Mrs. Dexter of Sandwich, Mass. These plants, together with others already at the Arboretum, which flowered profusely this year, now form a special grouping on

the north slope near Germantown Avenue. When of full flowering size these Fortunei hybrids are exceedingly showy and represent a radical departure in Eastern rhododendron culture. They will be interesting to observe in the Philadelphia region. Cions of several additional selections have since been received from Mr. Samuel Everitt, while cuttings are being rooted of further color variations in the possession of Mr. Henry F. duPont.

In other rhododendrons a further donation of seeds of approximately 60 species from the Royal Botanic Garden at Edinburgh have made plants which will be ready for setting out this spring for general cultural and hardiness testing. A shade house of Shipmast Locust construction will soon be erected for use in this project. Other very acceptable acquisitions in rhododendrons and azaleas include pollen for hybridization purposes from Mr. Samuel Everitt, Mr. Charles Willing of Chestnut Hill, and from Swarthmore College. Cuttings from hardy azaleas have been received from F. D. Moore and Sons, Narberth. These nurseries have also recently presented the arboretum with a fine 18-ft. specimen of *Styrax obassia,* our original plant being lost following the severe winter of 1934-35. Both the Styrax and a shapely young Franklin Tree (*Franklinia alatamaha*), a gift last spring from Mrs. R. M. Hogue of Germantown, have been planted as background specimens in the new Germantown Avenue rhododendron area.

*The Clematis Group.* A collection of species and varieties of Clematis has already attained significant proportions at Chestnut Hill. Summer visitors are greeted by numerous showy blossoms on the Rose Garden balustrade and on posts erected this year through the lower conifer nursery. Some notable further gifts have been made to the collection this season. Among such welcome additions were plants of 8 varieties from J. I. George and Son of Fairport, New York, who have already contributed very many of our existing forms; plants of 8 species from Henry Kohankie and some of Painesville, Ohio; 3 species from the Morton Arboretum; 23 species and varieties from the Montreal Botanical Garden; cuttings of 5 varieties from Mrs. Charles Platt; as well as seeds of 18 further types from Mr. Louis Vasseur and the Botanic Gardens of New York, Basle, Ville de Nantes, Stockholm and Leningrad.

*A Testing Service.* Worthy of special note among the season's acquisitions are a number of plants contributed specifically for purposes of testing and appraisal under Philadelphia conditions. Examples of such plants are two new Kurume hybrid azaleas produced and contributed by the de Wilde Rhododendron Lake Nurseries, seven of the new *Azalea Vuykiana* named hybrids presented by the Vuyk Van Nes Nurseries, Inc., and from Andorra Nurseries a curious natural variant of *Rhododendron maximum.* Such plants as these will be incorporated in display groupings but they will also be subject to close observation for a number of flowering seasons, and on agreement with their donors, will not be distributed by the Arboretum until further permission is granted. This testing service for new varieties of woody plants is open to any who wish to avail themselves of it so long as realistic limitations are recognized regarding the numbers of seedling individuals which can be reasonably handled from a given source.

Other new plant varieties recently contributed for observation in this region include the Bartlett Chestnut (*Castanea mollissima var*) from the Bartlett Tree Research Laboratory, the "Christine Buisman" Elm, *Ulmus carpinifolia,* a Dutch Elm disease-resistant form from the U. S. Department of Agriculture, and the new Azalea "Mephistopheles," the hybrid *Rosa rubus* and two named hybrids of *Prunus incisa x campanulata* parentage from Captain Collingwood Ingram.

*Further additions.* Our standard collections have been further enhanced by grafts and cuttings of several unusual conifer variants, including the rare *Pinus densiflora oculis draconis,* from Col. R. H. Montgomery, by seeds of the hardy Cedar of Lebanon from the Arnold Arboretum, by budwood of several of Mr. Adolf Muller's Flowering Dogwood selections from the DeKalb Nurseries, by plants of *Gymnocladus, Clerodendron,* etc., from the Arboretum of the Barnes Foundation, as well as by plants of a fine collection of 27 species of *Cotoneaster* and various other genera from the nurseries of Princeton University. In the fernery may be seen some excellent Platyceras, a recent gift of Mrs. F. W. Dixon. A number of graft understocks in rhododendrons and conifers very kindly provided by Koster Nurseries of Bridgeton, N. J., were invaluable for the propagation of many of the above forms.

In all, a total in plants of 93 different species and varieties have been received during 1946, together with cuttings and cions of 124 additional species and varieties and 165 packages of seeds. With very few exceptions these many plant materials have been secured through the interest and generosity of friends of the Arboretum. To all of these friends, many of whom have not been mentioned by name in the foregoing paragraphs, our sincere thanks are expressed.

H.T.S.

# An Exhibit of Fruiting Shrubs for Fall Gardens

The Morris Arboretum, cooperating with Swarthmore College, Arthur Hoyt Scott Foundation, staged an exhibit of ornamental fruits at the fall flower show of the Pennsylvania Horticultural Society, November 8 to 10 in Swarthmore. The show drew a record breaking attendance of nearly 8000. The exhibit included fruits of more than 50 shrubs and trees which are among the best for fall color and interest in gardens.

Large branches were arranged as a shrub border with a neat edging of ivy and an undercover of gray, green or bronze foliage to set off the berries.

The long, warm fall and the heavy fruiting of plants this year produced an abundance of berries, contributing greatly to the success of the exhibit. Another factor was the selection of individual plants outstanding for their fruits. Many gardens could be lit with color and shining berries in the fall if one would select personally good fruiting plants. Some of the berries arousing the most interest were: the bright red, large-fruited pyracantha, contributed by Mrs. A. H. Scott; a lemon-yellow pyracantha; a type of *Viburnum dilatatum* with multi-colored fruit heads varying through shades of yellow, orange and red; the compact green clusters of *Phelledendron chinense;* a dusty rose-pink *Evonymus yedoensis;* and the tightly-clustered light-vermillion fruits of an *Ilex serrata.*

The exhibit was awarded a gold medal.

M. A. Lancaster

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# Notes From the Laboratory

## Spray Results

*Fermate for Black Spot on Roses.*—In normal seasons yellow Cuprocide has given good control of black spot of roses. During the wet summer of 1945, however, (precipitation June-August 4.6 inches above normal) control proved inadequate. Defoliation was so severe that growth was far below average and plant losses abnormally high during the succeeding winter. Fermate (1½-100) was used in place of Cuprocide during 1946. A sticker was employed as well as Nicotine and CPO when signs of aphids appeared. No sulphur was used. Spray applications followed a weekly schedule from May 25th to October 12th. In spite of an even wetter season during 1946 (precipitation June-Aug. 6.2 inches above normal) control of black spot by the use of Fermate was the best that has been observed in several years at the Arboretum. Very little leaf infection was seen during the entire season and, as a probable result of practically no leaf loss, and in spite of their weakened condition at the beginning of the year, the growth of many varieties was almost phenomenal.

*DDT on Bald Cypress and Boxwood.*—Bald Cypress (*Taxodium distichum*) is subject to attack by the Cypress Tip Moth, *Recurvaria apicitripunctella.* In a previous report (*Morris Arb. Bull.,* Vol. 4, No. 4) a lead arsenate spray at the time of greening was recommended as a satisfactory control. Last spring a 40% DDT wettable powder containing a spreader but with sticker added and used at the rate of 2 lbs. per 100 gallons, was substituted for the arsenate greening spray. No control was achieved until the normal arsenate spray was applied ten days later.

During the past season emergence and flight of the Boxwood leaf miner, *Monarthropalpus buxi,* commenced at the Arboretum on June 7th at 10:30 A.M. with three specimens of *Buxus microphylla japonica.* Emergence from these and several varieties of *Buxus sempervirens* continued for a week during a period of cool and showery weather. A spray of DDT was applied on June 7th, and because of subsequent rains this was repeated on the 11th and again on the 14th. A good kill of flying adults was observed following each application, yet emergence from the leaf undersides continued as well as intermittent oviposition in young shoots of the sprayed shrubs. On September 9th, 50 leaves per plant taken from current season shoots, random selection, of 8 varieties of Boxwood were examined for second generation infestation. This

count revealed an average number of active larvae per leaf as follows:

| | |
|---|---|
| *Buxus microphylla japonica* | 4.4 |
| *Buxus sempervirens arborescens* | 1.2 |
| *Buxus sempervirens aureo variegata* | 1.2 |
| *Buxus sempervirens elegantissima* | 0.0 |
| *Buxus sempervirens Handsworthii* | 0.3 |
| *Buxus sempervirens myrtifolia* | 1.0 |
| *Buxus sempervirens rotundifolia* | 1.2 |
| *Buxus sempervirens suffruticosa* | 0.0 |

Twenty-two feeding larvae were noted in a single leaf of *Buxus microphylla japonica*. With no spray protection, leaf miner attack on the varieties *elegantissima, Handsworthii* and *suffruticosa* is normally light. Control with DDT was not considered satisfactory.

## Tree Feeding

Several types of fertilizers have been used in the maintenance program with 126 of the mature shade trees in the Arboretum. The most extensive treatments in 1938-40 were with an 11-5-6 fertilizer applied variously in fall or spring at the rate of 2 lbs. per inch of trunk circumference at 4½ feet above ground. Application was by the crowbar method either within a 4-foot wide zone centered at crown spread or at 3-foot intervals within the area of branch coverage. Supplementary or independent treatments included the use of Bovung, additional bonemeal, mulches and cultivation treatments of peat moss cow manure, sludge, leaf mold, etc. Twig elongation counts have usually indicated a positive response to artificial fertilizers, with shoot growth increases in the general range of 10-70%; but this is actually a very small amount, scarcely to be considered significant in view of the fact that untreated trees during favorable growing seasons have often done far better. Increases up to 270% have followed the use of cow manure applied in the fall to a variety of European Beech and so far no other material or combination of materials has been found to equal it. During an earlier 3-year period the same tree had given very little response to nearly 1000 lbs. of chemical fertilizer.

Before investigating other methods of restoring needed vigor to some of these trees it was decided to run one further test of chemical fertilizers on thirteen representative tree types. Some of these trees are growing in the rather shallow and gravelly neutral to acid soil of the hill-top near the Administration Building while others are in deeper soil in the south valley. None had been fertilized during the previous four years. Six additional trees were selected as checks. Commencing on April 22nd, 1946, each tree was fed with an 11-5-4 fertilizer (ammonium sulphate, superphosphate and muriate of potash)

| | Pounds of Fertilizer | Shoot growth in inches and as percentage of growth in 1944 | | |
|---|---|---|---|---|
| | 1946 | 1944 | 1945 | 1946 |
| *Abies cilicica* | 40 | 3.1<br>100% | 2.6<br>85% | 2.9<br>92% |
| *Abies lasiocarpa arizonica* | 20 | 2.3<br>100% | 1.6<br>70% | 1.5<br>66% |
| *Carya ovata* | 155 | 2.5<br>100% | 1.3<br>54% | 2.3<br>92% |
| *Cedrus atlantica argentea* | 95 | 2.0<br>100% | 1.5<br>75% | 1.5<br>72% |
| *Cladrastis lutea* | 160 | 5.8<br>100% | 3.4<br>58% | 7.9<br>135% |
| *Cornus florida* (2 together) | 195 | 3.4<br>100% | 3.4<br>100% | 3.8<br>110% |
| *Cornus florida pendula* | 85 | 8.6<br>100% | 7.4<br>86% | 6.1<br>70% |
| *Diospyros virginiana* | 100 | 6.5<br>100% | 5.2<br>81% | 4.5<br>69% |
| *Fagus sylvatica var.* | 240 | 3.4<br>100% | 2.7<br>79% | 3.9<br>115% |
| *Fraxinus excelsior aurea* | 150 | 3.1<br>100% | 3.3<br>108% | 2.7<br>87% |
| *Picea pungens glauca* | 80 | 3.3<br>100% | 3.2<br>98% | 3.1<br>96% |
| *Prunus subhirtella pendula* | 60 | 7.2<br>100% | 8.5<br>118% | 12.0<br>166% |
| *Quercus conferta* | 225 | 3.8<br>100% | 3.5<br>92% | 3.4<br>90% |
| Av. growth all treated trees | | 4.2<br>100% | 3.6<br>85% | 4.1<br>97% |
| *Carya ovata* | None | 5.4<br>100% | 5.8<br>109% | 3.8<br>71% |
| *Cedrus atlantica* | None | 5.0<br>100% | 2.9<br>58% | 3.0<br>61% |
| *Cornus florida* | None | 4.6<br>100% | 2.9<br>64% | 3.4<br>74% |
| *Fagus sylvatica atropunicea* | None | 4.5<br>100% | 3.6<br>78% | 4.9<br>107% |
| *Fraxinus excelsior* | None | 3.8<br>100% | 7.1<br>188% | 6.6<br>175% |
| *Prunus subhirtella pendula* | None | 17.4<br>100% | 11.8<br>68% | 12.0<br>69% |
| Av. growth all checks | | 6.8<br>100% | 5.7<br>94% | 5.6<br>93% |

Fig. 28. A comparison of shoot growth for the years 1944, '45 and '46. Thirteen species were fertilized in April, 1946. Six species received no treatment.

in an amount arrived at by addition of height in feet to spread in feet to trunk circumference in inches—expressed in lbs. of fertilizer. This poundage was reduced by 25%—40% for the conifers. Application was at 3-foot intervals from trunk to branch spread with the use of a water fertilizing gun operated at 300 lbs. pressure Calculation of amount and mode of application followed essentially the St. Louis method described by Beilman (Missouri Bot. Gard. Bul. 27:8, p. 119. Also Nat. Shade Tree Conf. *Proceedings,* V. 10, 1934, p. 114).

In spite of the heavy applications involved, and in spite of a soil which for a few trees was so shallow that the gun could be sunk only 8 or 10 inches before striking bed rock, no injury whatever was noted. During the growing season few effects of any kind could actually be detected. In some cases the foliage appeared to be improved in color and with European Beech and especially Weeping Dogwood it was increased considerably in size. Measurements were made in the fall of twig elongation for the past 3 years for 30 twigs on each tree (See Fig. 29). This average growth expressed in inches and as percentage increase or decrease over 1944 is shown in Fig. 28. Taken as a whole, the effect of these particular treatments upon subsequent growth is very slight indeed. Fertilized trees average slightly more growth than checks but any improvement is at best less than normal seasonal variation. The Yellow-wood (*Cladrastis*) and Weeping Cherry probably received some benefit but the Weeping Dogwood, in spite of improved foliage, made less growth than before. No conifer gave any significant response.

It is worthy of note that in spite of wet summers low precipitation during March and April has been reflected in generally diminished tree growth during both 1945 and 1946. Whether this program would have been productive of better results in a season of normally distributed rainfall is open to question. Whether a carry-over effect may be observed during the coming year is yet to be determined. One point concerning these trees at least receives emphasis,—the need for a careful investigation of limiting growth factors *other* than nitrogen, phosphorus and potash as they apply to the particular environment and soil type of the Morris Arboretum.

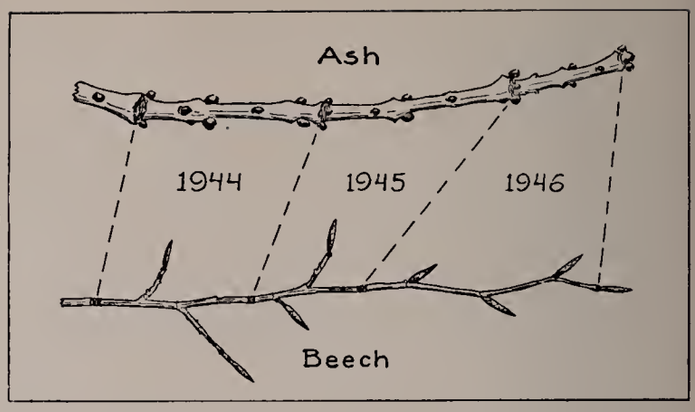



Fig. 29. The method of growth measurement. Comparisons of annual growth for three or more years are made *on the same shoot.* Averages for a series of shoots measured in this way provide a reliable seasonal growth index. All species under consideration make annual growth which can be readily recognized for several seasons past because of the prominent enduring bud scale scars.

Henry T. Skinner

Gray Herbarium
Harvard University

# Morris Arboretum Bulletin

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Fig. 30—Alcock Spruce.
*Picea bicolor* (Maxim.) Mayr.

Photo by Gustave Liebscher

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# The Alcock Spruce

The tree of our cover photograph happens to be one of the rarer spruces, the Alcock Spruce, *Picea bicolor,* as it grows at the Morris Arboretum up the slope from the Hillcrest Avenue gate. This is the species which Ernest H. Wilson once described as "the handsomest of all the spruce trees which can be grown in this climate." His judgment is evidently based upon the performance of some particularly fine specimens which may still be seen at the Walter Hunnewell Arboretum at Wellesley, Mass. When Wilson wrote in 1916 the largest of these was then 43 feet high with a branch spread of about 40 feet. Today these trees are considerably taller and according to the most recent available information are still in excellent health. The specimen pictured at the Morris Arboretum is a vigorous although much younger tree about 18 feet in height with a branch spread of perhaps a foot less. Its shape is evidently typical: a broad pyramid formed by a central trunk thickly clothed with wide-spreading and somewhat ascending branches. Foliage color of this spruce is grayish green in general effect, the gray tone resulting from conspicuous white stomata bands on both the upper and lower leaf surfaces. Young branchlets are at first yellowish but soon turn to a lustrous reddish brown and the trunk is quite distinctive with its brownish bark peeling into aggregates of thin plates of ¼ to 1 inch diameter.

The Alcock Spruce was discovered on Mt. Fujiyama in Japan in 1860 by J. G. Veitch who named it for Sir Rutherford Alcock, then British minister at Yedo. Subsequent studies have shown it to be confined in distribution to the central range of the main island of Japan. It occurs in mixed forests but even in its native state has always been too scarce to be of any economic importance. Although introduced to Europe as early as 1861, it is still a rarity under cultivation there as well as in America. Like *Picea Maximowiczii,* one of the most beautiful of the green-foliaged spruces, also from Japan where it is now nearly extinct as a native tree, the Alcock Spruce seems to have definite ornamental value and may have economic possibilities worthy of the future attention of the geneticist.

H.T.S.

# Tree Breeding at the Arboretum

During the past year many people have asked about paper bags in the Morris Arboretum. These bags have been placed on the trees to protect the female flowers from outside pollination prior to making controlled crosses. This controlled pollination work is a part of the breeding program of the Forest Genetics Project of the Northeastern Forest Experiment Station, Philadelphia, working in cooperation with the Morris Arboretum. The work is under the direction of Dr. E. J. Schreiner who is assisted by Dr. Jonathan W. Wright.

Unlike most crop plants and ornamentals, trees used for timber production have never been selected or improved in any way. We still plant seedlings from wild trees. Until a few years ago there was no need for improved timber types, but the present timber shortage has made this need evident.

The present project started in 1924 in Maine as a poplar hybridization program for a paper company. In 1937 the work was taken over by the Northeastern Forest Experiment Station, then at New Haven, Connecticut, and the scope of the work was enlarged. During the war the New Haven station was closed down and the project was moved to the Morris Arboretum which is well suited to tree breeding because of its large collections of important timber tree species.

The choice of trees on which to work is unlimited, since all need improvement. Practical considerations, however, have limited the breeding to a few of our most important genera: pine, spruce, fir, maple, oak, and ash. Improvement is being especially sought in the matters of disease and insect resistence, growth rate, tree form and wood quality. To obtain this improvement reliance is being placed mainly upon crosses between closely related species and between outstanding trees within one species. The selection of these outstanding trees from wild forests promises to be a large part of the work.

The bagging and pollinating techniques now being used were developed by Dr. Schreiner and his associates over a period of more than 20 years to meet the specialized needs of the forest tree breeder. The techniques are of interest since the bags are so noticeable to the visitor, and since the techniques differ in some details from those in use by crop plant breeders.

The bags are placed over unopened female flower buds before the flowers reach the stage where they can be pollinated by the pollen floating in the air. Since most wind-blown pollen is very fine and can sift through the smallest crack, the bags must be nearly airtight. In addition they must be weatherproof, easily applied, and must not injure the young flowers, leaves or shoots. Four different types of bags have been found useful in varying degrees: glassine, kraft paper, sausage casing and vegetable parchment.

Glassine and kraft paper bags are always used together since the former are not weatherproof and the latter are not pollen-tight. The first operation in bagging is to wrap a small piece of absorbent cotton around the selected branch at the point where the bag will be tied. This cotton keeps the bag from slipping and keeps foreign pollen from being blown or washed into the bag. A glassine bag is slipped over the flower cluster to be protected and tied tightly with twine. A kraft paper bag is tied over the glassine bag. When the bagged flowers are fully open and ready for pollination, the outer bag is slipped off and a tiny hole made in the glassine. The pollen is blown through this hole. A new glassine bag is put over the punctured one and the kraft paper bag replaced. The bags are left on the branch until all danger of uncontrolled pollination is past. These kraft paper and glassine bags have been used quite successfully for a number of genera. However, they do offer two disadvantages: application of two bags on each branch is time-consuming, and the bags absorb light and heat and apparently cause etiolation and heat injury to the enclosed branch, especially late in the season.

The sausage-casing bags are made from a cellophane-like material. The casings are cut into convenient lengths and tied securely with cotton. Only one bag is necessary for each branch as the casings are pollen-tight and waterproof. The bags are fully transparent, allowing easy examination of the developing flowers. When wet the bags are limp. In this condition they may whip in the wind and injure the enclosed flowers.

Vegetable parchment bags are made from the same material as that used for wrapping butter. The parchment is very tough when wet and withstands considerable wind and rain. It is nearly white, reflecting light and heat. Unfortunately the parchment bags are not available commercially (except in very large lots), so must be hand-made in the desired sizes with waterproof glue. When pollinating flowers enclosed in either sausage casing or parchment,

the branch end of the bag is loosened slightly, the pollen is blown in, and the bag is retied.

The glassine, sausage casings and parchment are all very brittle when dry. They do not often break while on the tree but must be humidified before application.

Two methods of pollination are in use. In the oaks, ashes, pines and other wind-pollinated species, the pollen is placed in a small glass vial fitted with a medicine dropper drawn to a fine point. The pollen is sucked into the dropper and blown from it into the bags. The droppers are inexpensive and can be thrown away after being used. Several vials and droppers can be carried around conveniently in a pocket, even when it is necessary to climb large trees, but most of the insect-pollinated maples and basswoods yield so little pollen that it is hardly possible to use the dropper technique. In working with these species it is usually necessary to brush the pollen onto the female flowers.

If the bags are not left on too long after pollination they do not seem to injure the flowers or young seeds in most species. On the contrary, they often furnish more nearly optimum conditions than prevail in the outside air. This is especially true in frosty weather when the bags provide just enough insulation to prevent frost injury. After severe frosts a few bagged branches may provide the only seed on an entire tree. Usually the bags are removed a week or two after pollination, or as soon as all danger of unwanted pollination is past. Then at intervals during the summer the flower clusters are checked for amount of fruit development. A few weeks before the seed is supposed to mature the branches are again covered—this time with cloth bags to catch any prematurely dropping seeds. A final visit to collect the seeds and bags is made to each branch after the seed ripens in September or October.

JONATHAN W. WRIGHT

# The 1947 Planting Program

Nineteen forty-seven marked the beginning of a threefold, postwar, planting program at the Arboretum: 1) the development of background plantings in areas until now used only for grazing; 2) improvement of existing evergreen plantings; 3) moving crowded plants from the nurseries, overgrown during the war.

*Development of new areas.* In the big, gently rolling north meadow of Bloomfield Farm were planted 77 Oak trees averaging 12-15 feet in height and representing 47 species and hybrids. These oaks begin to outline the plans envisioned for this area: the front entrance drive through tall enclosing trees; a wooded ridge from which open long vistas edged with flowering cherries, crabapples and other spring-flowering plants; a Paulownia and Lilac garden to include the useful, little-known Lilac species as well as the "100 best" hybrids. Stretching north from the Lilac garden will be a wide grass walk deeply bordered with flowering shrubs in front of tall trees. The oaks planted on the knoll in the northwest corner will shelter an overlook looking back across the meadow to the arboretum tower on the big hill. This knoll will be a center for plants decorative in fruit and of interest in winter with shaggy or colored bark, seed-pods, unusual buds or picturesque habit.

Of the 47 varieties of oaks planted this spring, 34 are new to the Arboretum. As would be expected of a genus whose distribution is predominantly in the eastern and central United States, most of the oaks planted are native to this country, though ten are native to Europe or Asia.

*Improvement of existing plantings.* In areas little developed by Mr. and Miss Morris, in plantings overgrown and crowded, and in plantings thinned by the loses there is need for improvement. The existing evergreen groups around the Hillcrest and Meadowbrook gates are being extended to give a feeling of richness and year-round interest at the two main entrances. For lightness, deciduous plants with brilliant fall color or with winter or early spring flowers are to be interspersed among the evergreens.

Near the Meadowbrook gate the broad lawn crowning the arboretum hill is dominated at present by the big Beeches, Sophora and European Ashes set out by Mr. Morris about sixty years ago. The effect of these deciduous trees will be enhanced, and at the same time they will

give "ceiling" to the firs and spruces being planted near them. The irregularity of a few pines will help soften the formality of the other evergreens. Because of the importance of this entrance the finest and most ornamental firs and spruces will be placed in this area. The main road curves through them before coming upon the unexpected vista across the Whitemarsh Valley. From one of the winding grass paths on the south edge of the hill will be a conifer-framed view across the Arboretum, terminated by Sugarloaf Hill.

Three pines new to the Arboretum were planted: *Pinus contorta latifolia,* the Lodge-pole Pine of the Rocky Mountains received from the Allegheny Forest Station; *Pinus echinata,* a rangy native Pine from the Forestry Station at Mt. Alto, Pa.; *Pinus peuce,* the narrow, rich Macedonian Pine, a gift from the Masonic Home in Elizabethtown, Pennsylvania.

Several varieties of dwarf Spruce have been added, all gifts from Col. Robert Montgomery's large collection in Cos Cob, Connecticut: *Picea abies* dwarf (Cos Cob #6), *P.a. Veitchii,* and two *Picea glauca nana.* The comparative smallness and grayness of the last planted near the large Purple Beech brings out the dark, graceful beauty of the Beech and repeats its rounded form.

Five large-growing spruces, also gifts from Col. Montgomery, were planted: *Picea abies compacta, P. glauca. P. Maximowiczi, P. omorika* and *P. polita.* Additions in firs include: *Abies Fraseri* dwarf, from Col. Montgomery; *A. holophylla,* a gift of the Scott Foundation; and *Abies lasiocarpa arizonica,* a choice specimen presented and planted by Mr. James Gillin.

Two procumbent yews, *Taxus baccata repandens,* and the upright *T. baccata Overeindi* which were planted, will be part of a group dominated by a weeping cherry and two firs, *Abies nobilis* and *Abies cephalonica.*

On the southeast brow of the hill is to be seen a fine specimen of Dwarf Red Cedar, *Juniperus virginiana globosa,* given by Mr. James Gillin. It is the first step toward planting the entrance-area of a future memorial to Mr. and Miss Morris.

A thirty-year old Weeping Hemlock (*Tsuga canadensis pendula)* was moved from its crowded quarters at the foot of the Germantown Avenue slope to a prominent position near the Meadowbrook Gate. Moving the five-ton ball required ingenuity and patience for the arboretum does not possess equipment for handling large trees.

To the delight of neighbors and friends of the arboretum a start has been made (above the Lodge entrance) in the removal of excess Norway Maples along Hillcrest Avenue, thereby making available for intensive planting a choice strip of ground. At the same time beautiful views both from without and within the arboretum, hitherto interfered with by the wall of Maples, are being opened up, such as the superb one across the Japanese Garden to the large blue Atlas Cedar on the slope beyond. The trees to be planted in the newly liberated area, chiefly Arborvitaes, Chamaecyparis and Juniper interplanted with winter and early-spring-flowering trees and shrubs, will form vistas complementing the slope and pointing up some of the finest trees in the arboretum. Among the plants set out are *Chamaecyparis lawsoniana* and seven of its varieties, *C. nootkatensis glauca,* four varieties of *C. pisifera,* twelve of *Juniperus chinensis,* four types of *J. virginiana,* a *Libocedrus decurrens,* six varieties of *Thuja occidentalis.* A specimen of a dense slow-growing hemlock, *Tsuga canadensis* var. *Coplen,* presented by Mr. John C. Swartley, was also planted in this area; and nearby two forms of hemlock, *Tsuga canadensis microphylla* and a thick, full, unnamed form, both gifts of Mr. Charles Jenkins. Other plants in this area were received from Mr. Gustaf Malmborg of the Masonic Home in Elizabethtown, the Allegheny Forest Experiment Station, and again our generous contributor, Col. Robert Montgomery. Given to the arboretum as small plants about twelve years ago, these evergreens have been growing into sizeable plants in the nurseries until their recent assignment to permanent locations.

At the present time beds are being prepared and dug in the northwest section of the Oak Avenue meadow for Azaleas. For the time being they will be predominantly *Rhododendron japonicum* seedlings, products of Mr. Skinner's earlier hybridization work. With their orange to yellow flowers they have been a conspicuous feature of the Oak Avenue Nursery for the past three or four years. Planting will be delayed until the Azaleas are in flower so that the best color arrangements may be made.

Thus a beginning has been made in the post-war resumption of planting. Other plans, including some which contemplate departure from traditional arboretum practices, are in various stages of development and will be reported on in future issues of the Bulletin.

Margaret A. Lancaster

# The Organic Fungicides for the Control of Certain of Our Shade and Ornamental Tree Diseases[1]

*by* Spencer H. Davis, Jr.

During the past few years some fields of agriculture have seen a very decided change in the kinds of chemicals for combating their disease problems. The two old standbys — copper and sulfur — have the competition of many new organic fungicides in the race for popularity by virtue of providing better disease control and having less toxic effects on the hosts. The vegetable and fruit growers of the country have benefited greatly by these changes. Those interested in plants with an aesthetic value rather than a food value have received little benefit thus far. During the summer of 1947 an attempt was made to ascertain the value of some of these new organic fungicides in solving several shade and ornamental tree problems.[2]

Unfortunately, studies could not be so exacting as those conducted with vegetables and fruit. In studies with these new organic sprays on crops such as potatoes, experimental plots may be laid out so that all plants are within a relatively small area and replication and randomization of the treatments within these plots allow the data to be viewed very critically. In fruit studies the test plots are of the same age and variety and again the replication and randomization of treatments allow critical review of the data. On the other hand, an arboretum is planted with a view to beauty and is a collection of as many species as possible. It would be an uninteresting place indeed, if it were planted in rows like a potato patch, or if it had the sameness of species and varieties as found in an apple or peach orchard. Thus, when an experiment is laid out at the Arboretum, the individuals receiving treatment may be widely scattered, varying in age, limited in number, and made up of different varieties or even species. In the varying locations, a completely different ecological set-up may cause a given tree to have greater or lesser vigor and consequently be more or less susceptible to a given disease. Thus, the records of disease control on two trees a quarter-mile apart should not be compared. Certainly the varietal susceptibility of various rosaceous plants to the rusts precludes any valid discussion on the merits of various treatments when the varieties of the hosts are not definitely known.

Recognizing these many limitations to a critical review of results, these notes are presented on the control of a few diseases. However, if this work is repeated for a number of years, and if enough similar studies are made at other places, we should in time have a more complete picture of the value of the newer fungicides in controling the diseases of our shade and ornamental trees and shrubs.

In the work done at the Arboretum the dates of application for the evergreens were May 3, 16 and 27. The deciduous trees were treated on these dates plus June 10 and 28. Of the studies conducted other than at the Arboretum, the pears were sprayed on April 18, 26, and May 5 and 15, and sassafras on only the last three of these dates. These latter two studies were conducted at Cheswold, Delaware.

The compounds and rates used (pounds per gallon) were: Bordeau, 8 (copper sulphate)-8 (lime)-100; Micro sulfur, 6-100; Parzate (zinc ethylene bisdithiocarbamate), 1½-100; Zerlate (zinc dimethyl dithiocarbamate), 1½-100; Fermate (ferric dimethyl dithiocarbamate), 1½-100; Puratized N5-E (phenyl mercury triethanol ammonium lactate), 1 pint-100; and Bioquin 1 (copper-8-hydroxyquinolinolate), 1-100.

Host: Horsechestnut (*Aesculus carnea, glabra, Hippocastanum* and *octandra*.)

Disease: Leaf blotch (*Guignardia aesculi*)

| *Compound* | *Percentage Blotch* |
|---|---|
| Zerlate | 2 |
| Parzate | 7 |
| Bordeaux | 11 |
| Fermate | 82 |
| Puratized | * |
| Untreated | 100 |

[1]Published as Miscellaneous Paper No. 43 with the approval of the Director of the Delaware Agricultural Experiment Station. Contribution No. 9 of the Department of Plant Pathology.

[2]The writer wishes to thank the E. I. duPont Co., for supplying the Parzate, Zerlate, and Fermate; the Gallowhur Chemical Corp., for Puratized; the Monsanto Chemical Co., for Bioquin; and the Morris Arboretum, with which these studies were cooperatively conducted.

* only moderate control early in the season and no control in late summer.

INJURY: No treatment caused injury except Bordeaux which caused roughened leaves and small necrotic spots on leaves and petioles.

RATING: Zerlate and Parzate, first; Bordeaux, second; Fermate and Puratized of no value.

---

HOST: Hickory (*Carya ovata*)

DISEASE: Leaf spot (*Gnomonia ovata*)

| *Compound* | *Percentage Leaf Spot* |
|---|---|
| Zerlate | 0 |
| Parzate | 1 |
| Puratized | 3 |
| Fermate | 30 |
| Untreated | 35 |

INJURY: None.

RATING: Zerlate and Parzate, first; Puratized, second; Fermate of no value.

---

HOST: Sassafras (*S. officinale*)

DISEASE: Anthracnose (*Gleosporium fructigenum*)

| *Compound* | *Percentage Disease* |
|---|---|
| Fermate | 4 |
| Untreated | 34 |

INJURY: None.

RATING: Fermate satisfactory.

---

HOST: English hawthorn (*Crataegus Oxyacantha rosea*)

DISEASE: Leaf blight (*Entomosporium theumenii*)

| *Compound* | *Defoliation* | |
|---|---|---|
| | *August* | *October* |
| Bordeaux | none | very slight |
| Puratized | very slight | complete |
| Untreated | complete | —— |

INJURY: Bordeaux caused roughened and necrotic spotted leaves and petioles, and slight burning of the flowers; Puratized gave no injury.

RATING: Bordeaux, first; Puratized, second.

NOTE: Refer to control of Entomosporium leaf blight on pear.

---

HOST: Pear (Keiffer variety)

DISEASE: Leaf blight (*Entomosporium maculatum*)

| *Compound* | *Defoliation* | | *Fruit* |
|---|---|---|---|
| | *September* | *November* | |
| Parzate + lime | none | none | good |
| Bioquin 1 | none | none | good |
| Untreated | 90% | complete | none |

INJURY: None other than slight bronzing of the leaves in late summer with Bioquin 1 treatment.

RATING: Parzate, first; Bioquin, second.

---

HOST: Red Oak (*Quercus borealis*)

DISEASE: Twig blight (*Sphaeropsis sp.*)

| *Compound* | *Twig Blight* |
|---|---|
| Puratized | none |
| Bordeaux | none |

INJURY: Bordeaux caused a roughening and crinkling of the foliage and a necrotic spotting, compared with the large, clean, smooth and glossy foliage with Puratized.

RATING: Puratized, first; Bordeaux, second.

NOTE: No untreated specimens were present for comparison of twig blight in the immediate vicinity, but trees in nearby locations were moderately blighted and this large treated tree (one treatment on each half) has been seriously blighted in previous years.

---

HOST: Sour gum (*Nyssa sylvatica*)

DISEASE: Twig blight (*Phomopsis ?*)

| *Compound* | *Blight* |
|---|---|
| Bordeaux | moderate |
| Puratized | moderate |
| Fermate | severe |
| Zerlate | severe |
| Parzate | severe |
| Untreated | severe |

INJURY: Bordeaux burned the edges of young leaves and caused slight necrotic spotting of the leaves and petioles. Puratized resulted in a heavy leaf fall in October from two of the three treated trees and remaining foliage was green rather than colorful with typical fall-coloration.

RATING: The slight control with Bordeaux and Puratized was considered offset by the injury factors. No treatment was considered adequate.

---

In the row of unnamed varieties of *Crataegus,* two trees were sprayed with each compound. The individual susceptibility of the hosts to the quince rust (*Gymnosporangium claviceps*) was not known. While the counts made of 500 fruits on each bearing tree are thus not indicative of the effectiveness of the compounds, the following data are given on the amounts of infection: unsprayed—45 and 22 per cent;Puratized—8 and 7 per cent; Fermate, Zerlate and sulfur—0 per cent. No fruit was present on the two trees receiving Parzate. The only injury observed in this study was a moderate chlorosis in midsummer on one of the trees receiving Zerlate.

Treating Norway maples (*Acer platanoides*) with Parzate in mid- and late-May moderately controlled anthracnose (*Gleosporium apocryptum*) in mid-summer, but by early fall these trees were about as badly infected and defoliated as the untreated. (These observations were made at Georgetown, Delaware.)

Two varieties of red cedar (*Juniperus virginiana glauca,* and *J. v. Schottii*) which are particularly susceptible to the quince rust (*G. claviceps*) were treated with Puratized before and during the formation or rust spores (*telia*). neither inhibition of spore production nor injury to the trees occurred.

Austrian pine (*Pinus nigra austriaca*), flowering dogwood (*Cornus florida*), and black wal-

nut (*Juglans nigra*) were also treated with the various compounds used on other hosts. The presence of disease was so variable that no conclusions can be drawn. Some specimens of pine were free from disease while others treated with the same compound were heavily infected with the tip blight (*Sphaeropsis ellisii*). *Myxosporium* twig blight was very erratic in its appearance with the various treatments on dogwood. No compound caused injury on any of these hosts although the normal fall coloration of the dogwoods appeared to be delayed by Puratized.

Obviously, these studies and the ratings given the compounds are very preliminary. The results are from one season's work only and the number of plants in each group was small. However, it seems safe to assume that future studies here and elsewhere will result in the adoption of more of the new organic fungicides for combating diseases of our shade and ornamental trees and shrubs.

●

# John Story Jenks and William M. Elkins

The Advisory Board of Managers of the Morris Foundation recently has lost through death two valued members, John Story Jenks and William M. Elkins. In their very active business carrers they found time to lend their talents to diverse cultural enterprises and movements in Philadelphia. Both students in their own right, they brought a sympathetic understanding to the problems of the educational institutions which they served so freely.

Mr. Jenks, a connoisseur of art, particularly Chinese, was a member of the Board of Managers and one time President of the University Museum; of the Philadelphia Museum of Art; of the Thomas W. Evans Museum and Institute Society; and of the Fairmount Art Association. His attainments in the field of art were recognized by the French Government in awarding him the decoration Chevalier d'Honneur. Mr. Elkins, a noted collector and student of books and paintings, was Vice-President of the Philadelphia Museum and School of Industrial Art and a trustee of the Free Library of Philadelphia.

The wisdom and counsel they contributed so generously in the Board of Managers of the Morris Foundation are gratefully acknowledged by the Arboretum.

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# ARBORETUM BULLETIN

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Fig 31. China-Fir (*Cunninghamia lanceolata* (Lamb.) Hook.)
Northerly tree at Bowling Green, Virginia.

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# China-Fir Trees at Bowling Green, Virginia

The purpose of this note is not to give a detailed account of this species of evergreen conifer native to China but rather to call attention to two superb old specimens in Bowling Green, Caroline County, Virginia.

Claims of the "largest" or "oldest" in almost any connection are hazardous; somewhere someone is likely to turn up with a "larger" or an "older." But if there be specimens of *Cunninghamia lanceolata* extant in the United States which in age, size, and beauty equal or surpass those in Bowling Green, it is hoped that those who have knowledge of them, either in the flesh or through published accounts, will challenge the writer's tentative claim. *The Morris Arboretum Bulletin* will be glad to publish such communications in subsequent issues, especially if accompanied by photographs, specimens, and accurate data (location, age, height, trunk dimensions, crown spread, etc.).

The species was discovered in China in 1702 by the botanical collector J. Cunningham, after whom the genus is named. Since then only one other species of the genus has been found—*Cunninghamia Konishii* from Taiwan (Formosa). *Cunninghamia lanceolata* is widely distributed in mountain valleys of central and southern China where under forest conditions it forms magnificent trees up to 120 feet in height and 18 feet in girth, with straight mast-like trunks clear of branches for half the height of the trees. The wood is light, soft, fragrant, easily worked, durable, and, according to E. H. Wilson ("A Naturalist in Western China"), the most generally useful timber, next to bamboo, in China. The bark is durable and often used for roofing houses.

The species was introduced into England (Kew Gardens) in 1804 by direction of the East India Company. In the warmer part of Britain it thrives. But even at Kew all specimens were killed down to the ground in the hard winter of 1894-95. (The species from Formosa is even more tender.) It is not surprising therefore that in the general Philadelphia region the Chinese species can at best be said to persist, so subject is it to recurring winter injury.

Southward it fares better. In Virginia and North Carolina the writer has encountered it occasionally in gardens where to all appearances it is hardy. However, the trees are, so far as observed, all relatively young. The greater the surprise, therefore, to find the two venerable monarchs in Bowling Green, compared with which all others seen are mere youngsters.

The trees are at the home of Mr. Roper Rains



Fig. 32. China-Fir. Southerly tree in winter condition at Bowling Green, Virginia.



Fig. 33. China-Fir. Southerly tree at Bowling Green, Virginia, showing dense appearance toward completion of Spring growth.

fronting on U. S. Route #301 at the southerly edge of Bowling Green, which lies about 40 miles due north of Richmond and almost exactly at latitude 38 degrees. Noting the trees in February, 1948, the writer's colleague Dr. E. T. Wherry a month later likewise inspected them, bringing them to the attention also of Dr. Hugo Iltis of Mary Washington College in Fredericksburg. Apprised by Dr. Iltis of the unique botanical feature nearby, the Fredericksburg *Free Lance-Star* published an illustrated article on the trees in its issue of May 8, 1948. The writer is indebted to this newspaper and to its photographer, Mr. James McKnight, for kind permission to use two of the photographs here reproduced (Figs. 31 and 32), one of which (Fig. 32) appeared in the *Free Lance-Star* article.

Mr. Rains informed the writer that the trees were planted by his grandfather, who obtained them from a Long Island, New York, nursery. Their exact age is not known but Mr. Rains is of the opinion that they are over 100 years old. They are part of a definite planting pattern in which are extant also two large Nordmann firs *(Abies Nordmanniana)*, and two old eastern hemlocks *(Tsuga canadensis)*, presumably all planted about the same time. One of the Nordmann firs is definitely declining; the other is in tolerable condition, measuring (in March, 1948) 78 feet in height and 34.7 inches in diameter at breast height. On the tenable assumption that the Nordmann firs are strictly contemporaries of the China-firs, the age of the latter might be arrived at indirectly but fairly accurately by counting the annual rings on the core of an increment boring in the declining Nordmann fir.

The two Cunninghamias are both in excellent condition. Because of their uniqueness, photographs of both are here reproduced. On the more northerly one (Fig. 31), being closer to the street, some of the side branches have been cut back because of wires, poles, and sidewalk. The southerly one (Fig. 32), standing somewhat farther from the street, has escaped mutilation except some natural curtailment of side branches on two sides by shading from neighboring trees. The following measurements were taken in March, 1948:

Northerly tree: Height, 64 feet; crown spread, 54 feet; diameter of single trunk below level of division into three stems, 39.5 inches; diameters of the three stems, 14.9, 18.0, and 22.5 inches.

Southerly tree: Height, 60 feet; crown spread, 67 feet; trunk diameter 3 feet above ground, 41.5 inches.

The Bowling Green trees shed small branches in large numbers, forming a thick litter under the trees (see Fig. 32), the shed branchlets still clothed with the now browned, stiff and sharply pointed leaves. As a result the crowns by the end of winter are somewhat less dense. But with the onset of spring growth they thicken, the trees taking on increasingly a beautiful rich dense woolly aspect to which our photograph (Fig. 33) does not begin to do justice. Mention should be made also of the fact that in the spring of 1948 the trees bore incredible numbers of staminate cones characteristically clustered at the ends of the branchlets.

No account of these trees can adequately portray Bowling Green's unique botanical treasure. Surely not the least of the distinctions of this charming community is that it is the enviable possessor and custodian of what are believed to be the largest and finest specimens of this noble species in the United States.

J. R. SCHRAMM

# Notes From the Laboratory

## SELENIUM AND THE INSECT PESTS OF BOXWOOD

*The Pest Problem.*—Boxwood growing in the Philadelphia region is troubled from time to time by at least three insect pests: leaf miner, mite and psylla. Boxwood leaf miner, one of the worst of these pests, is likely to be particularly injurious to the Japanese Box, *Buxus microphylla japonica,* and the taller-growing forms of the Tree (or so-called "American") Box, *Buxus sempervirens.* It is seldom serious on the English Box, *Buxus sempervirens suffruticosa.* The latter plant is, however, attacked in most seasons by the boxwood mite, a pin-point sized creature akin to red spider which infests the leaves in great numbers, and in their sucking produce a yellowish mottling of unhealthy appearance. Other forms of boxwood are infested with this insect but seldom so seriously. The third familiar pest is the small psylla or grayish, waxy-covered aphid which sucks the centers of the young leaves early in the growing season and causes them to assume a curiously cupped and deformed appearance. It attacks all varieties.




Fig. 34. The evidence of insect attack. A—Healthy foliage. B—Swellings on undersides of the leaves caused by leaf-miner. C—Mottling of the upper leaf surface caused by mites.

Until comparatively recently it had usually been found that if these three insects could be reasonably well controlled no further problems were especially serious, but of late years the picture has changed. English boxwood in particular has seemed overly susceptible to some of these pests but in addition individual bushes have all too often become scrappy and misshapen through the loss of whole branches which die quite suddenly as a result perhaps of winter injury or fungus attack. We now realize that these several symptoms are most probably due to a serious weakening of the plant by an additional and very insidious pest. This pest is an eelworm or nematode which feeds *within* the roots, killing them in large numbers and thus completely weakening the plant from the bottom up. Such a weakened plant becomes an immediate prey to drought, to winter injury or to insect or fungus attack. Nematodes are microscopic in size, they persist for some time in the soil in the absence of the plant host, and while they can be killed quite readily by methods of soil sterilization, up to the present no method of control has been found effective for killing them within the roots of infested boxwoods. The chemicals which kill them in the soil are usually fatal to the plant roots.

*Selenium* — The Boxwood collection at the Arboretum suffered a severe attack of leaf miner in 1945, and since the old nicotine and molasses spray gave at best rather mediocre results (little was then known of DDT in this connection), it was decided to test the possibilities of the poison, selenium, which Dr. W. E. Blauvelt was already using with marked success at Cornell University for control of the insect pests of greenhouse-grown chrysanthemums. Selenium is a poisonous element occurring naturally in local areas in the prairie states where it is absorbed by certain plants and is known to be fatally poisonous to cattle or human beings feeding upon such plants. As an insecticide, it is applied to the soil in which the plant grows; it is absorbed by the roots and acts as a stomach poison to insects subsequently feeding upon any part of the plant. Because it is so poisonous, and because in soil application it may be accumulated by many types of plants—fruits and vegetables as well as ornamentals — its use, even for experimental purposes, calls for the utmost caution at all times.

The first tests of selenium as a control for Boxwood Leaf Miner were made upon two species of greenhouse-grown boxwoods in the winter of 1945-46. Results were encouraging, and the following notes will describe the effect of these and numerous subsequent selenium applications upon the pest population and general vigor of outdoor-grown boxwoods in several species and varieties.

*Methods of Application*—Selenium was used in these tests in the form of the readily water-soluble sodium selenate, and the dissolved selenate was watered into the soil in amounts varying from ¼ gm to 3 gms per square foot dissolved in

sufficient water to thoroughly moisten the ground throughout the expected region of root penetration. As a general rule it was arbitrarily assumed that a desirable amount of water for this purpose is about 30 gallons per 100 square feet of soil surface. Small areas were thus treated by placing a given weight of the salt in the necessary volume of water and applying the solution with a sprinkling can. On larger areas the Hozon proportioner was found useful with the garden hose, although the advertised 10-1 delivery of the proportioner was found to be rather unreliably variable with differences of water pressure. During the present season a more convenient method of application has been used which seems quite satisfactory: the ground about the plants is first soaked very thoroughly with the hose and the necessary amount of selenium is dissolved in about 2 gallons of water and applied as evenly as possible with a fine sprinkler. Penetration of this more concentrated salt solution would probably be equally effective after a heavy rain provided one is certain that the ground has been evenly and completely moistened.

*Evaluation of Results* — Evaluations of the effectiveness of treatment upon control of the leaf-feeding insects have been arrived at by examination of approximately 50 leaves, random selection, per treated or check plant. In the case of leaf miner the number of ovipositions per leaf can be readily counted shortly after occurrence, and the number of such ovipositions resulting in new larvae can also be accurately determined within a few weeks. In the case of boxwood mite it has seemed sufficient to record this pest on a basis of presence or absence per leaf only.

In recording shoot elongation as being possibly influenced by the treatments, average lengths were taken of 50 current-season shoots per treated and check plants representing a distribution of 15 terminal shoots, 25 side shoots from these terminals and ten side shoots from lower down on each bush. Although not accurate, such a figure is felt to be reasonably indicative for a given plant. Root nematode populations could be determined on a comparative basis only. While microscopic examination yields valuable information regarding the nematode activity level in a given sample, the effects of general infestation of the root mass is usually so easy to recognize that with representative root portions the extent of infestation can be comparatively estimated by simple observation.

## THE CONTROL OF LEAF MINER

The first intended use of selenium at the Morris Arboretum was as a possible agent for control of the Boxwood Leaf Miner, *Monarthropalpus buxi.*

*The Insect* — The adult leaf miner is an orange-bodied fly about 1/10th of an inch long, which in bad infestations emerges in swarms from the lower side of the older leaves in late May or early June. Over a period of about a week the female flies deposit their eggs inside the leaves of newly developing shoots. Held against the light, each oviposition can be identified as a pale pinpoint spot. Within a few weeks newly-hatched larvae (the "miners") commence feeding inside the leaf. This feeding continues until cold weather in fall and recommences in spring. When full development is reached in April or early May the larvae pupate for a brief period to emerge as the new crop of adult flies. The mature larvae may be so voracious in their feeding that on a warm, quiet day in April an infested bush may audibly crackle with their activity.

*Treatments and Results*—During the winter of 1945-46 eight 18-inch nursery-grown plants of *Buxus sempervirens arborescens,* eight of *B. semp. angustifolia* and four 3-foot specimens of *B. microphylla japonica* were divided among four soil plots of 12 square feet each in a greenhouse bench. The leaves of all plants were already heavily infested with developing leaf miners. On March 11, 1946, Plot #1 received 2 grams of sodium selenate, plot #2 received 4 grams, plot #3, 6 grams, plot #4 no treatment. Development of the miner larvae was in no way affected. They pupated normally and emerged as flies in early May. Indiscriminate oviposition followed in the young leaves of all the plants. On August 29th a careful check was taken of the miner situation, since by this time the young larvae would normally be in a sizeable and active condition. The results were as follows: Through all varieties an average of 74% of the counted leaves showed oviposition scars, in some cases as many as 23 to a leaf. In general the numbers were highest in *B. microphylla japonica* and lowest in *B. semp. arborescens.* On a plot basis oviposition bore no particular relation to treatment. Plots #1 and #3 had the highest rate (80 and 81%) and the check plot #4 the lowest (64%). There had been abundant ovipositions, but the count of the number of these ovipositions which had developed into maturing larvae was especially revealing. In untreated plot #4, 29% (a little low in comparison with later findings) of the egg depositions had produced actively feeding larvae, while no larvae of any kind were found on the treated plots. If they had emerged from the egg stage they had evidently died with their first feeding.

A similar experiment was run concurrently on 2- to 3-foot plants of *B. sempervirens rotundifolia, B. semp. angustifolia* and *B. microphylla japonica* growing in a cultivated nursery. On April 11, 1946, the ground about four plants of




Fig. 35. The control of leaf-miner with selenium. A—Miner infested shoot from untreated plant of *Buxus semp. arborescens.* B—Healthy shoot from similar plant of the same species treated with sodium selenate in early April. Photographed in September.

each variety was treated with sodium selenate at the rate of 1 gram per square foot of branch spread. Four plants of each variety were left untreated. As before, the plants were heavily infested with leaf miners which matured and oviposited normally—(28 times on some leaves of treated plants). Allowing time for development of the new miners, examination was made for their presence on the following August 27th when it was found that while an average of 58% of ovipositions on leaves of check plants produced actively feeding larvae, no larvae at all could be found where the selenate had been used.

*General Observations*—Since these two tests were carried out, selenium applications have been made to numerous boxwood varieties in nursery rows and permanent plantings with usually very satisfactory results from the standpoint of leaf miner control. Where control has not been completely effective the first season, it is likely to be traceable to one of three reasons: (1) the selenate concentration may have been too low—the effective minimum seems to be about ½ gram per square foot; (2) application was made too late—it should preferably be done in spring *before* growth takes place; or (3) the amount of selenium solution was insufficient for contact with the spreading root system of an old established specimen. It is interesting to note that a late application made when shoot growth was half developed may not result in killing the larvae until late fall, but it is eventually effective. Furthermore, the nursery plants treated in 1946 showed complete control of leaf miner for two seasons. This year very light infestation is visible for the first time.

*Conclusions*—So far as this particular pest is concerned, selenium gives very fair promise as an effective control in the event that alternatives to present insecticides such as DDT are sought. It is perhaps one of the first instances where selenium has been satisfactorily used with a typically woody plant.

## BOXWOOD MITE

While common red spider frequently attacks boxwood along with a host of other plants, the brown colored slightly smaller and more specialized boxwood mite, *Paratetranychus yothersii* seems to do most of the damage at the Arboretum. In normal seasons it is particularly prevalent on the English Box in late summer (see Fig 34) but also attacks other species and varieties with the possible exception of those forms of *B. sempervirens* with deep green, leathery leaves such as *Handsworthii, aureo-variegata, bullata,* etc. Such forms are, in fact, usually the last to be bothered by leaf insects of any kind.

*Treatments and Results*—It was observed during the course of the succeeding summer that the selenium treatments of March 11 and April 11, 1946, were having a distinct effect not only upon the leaf miners but also upon the color of the upper leaf surfaces. No yellowish mottling was in evidence. Careful examination was consequently made on September 10, 1946, for signs of mite infestation. Among untreated plants growing under nursery conditions, 7% of the leaves of *B. semp. rotundifolia,* 3% of the leaves of *B. semp. augustifolia* and 24% of the leaves of *B. microphylla japonica* showed mite infestation. No evidence of such infestation, past or present, was discovered upon any treated plants of the same varieties. In 1948 these same treated plants show practically no indication of mite attack. More recent evidence indicates that Boxwood mites can be controlled on all varieties during a given season provided, as for leaf miner, that the selenium is applied in spring just before growth commences. Applications made at any time later are relatively ineffective the same season, especially with *B. semp. suffruticosa.* They do, however, tend to reduce the amount of infestation during the season following.

*English Box*—Throughout these tests it has been repeatedly observed that the English Box does not, unfortunately, give such a clear cut response to selenium treatments as do other varieties when the conditions of application are relatively ideal. Mites, for instance, may be controlled completely on some individuals, poorly on others. The reason for this may possibly be that selenium is most effectively absorbed when it is applied just before a period of vigorous shoot elongation. With dwarf-growing *B. semp. suffruticosa* shoot growth is never typically vig-

orous, and it is made over a rather protracted period. Unless it can be utilized promptly, it is likely that much of the selenium is leached from the soil before enough is absorbed to become effective.

## BOXWOOD PSYLLA

The small sucking psyllid or aphid, *Psylla buxi,* causes its typical leaf cupping on most varieties of boxwood at the Arboretum. It is particularly partial to the Tree and Japanese Boxes and seems most serious on the soft growth made in semi shade, but in heavy infestations it is quite general. This pest is readily controlled by a contact insecticide such as nicotine sulphate, but it is of interest to note that any selenium treatment which is effective for leaf miner or mite gives good control at the same time of boxwood psylla. See Figure 38. From general observations it appears that this insect is perhaps easier to control by this means than boxwood mite. Late treatments, which have been only partially effective on the latter, have on occasion still eliminated the psylla quite completely.

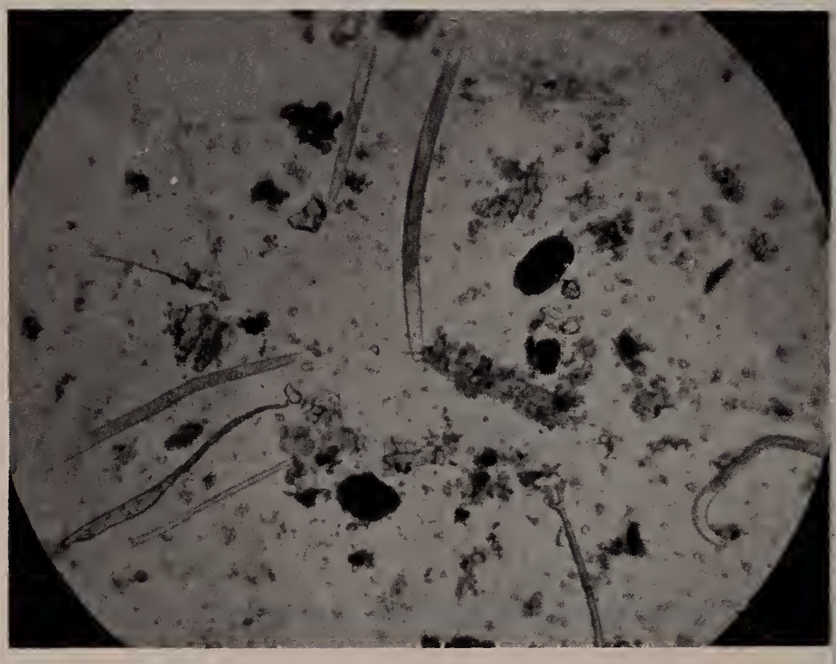


Fig. 36. Meadow nematodes from the roots of *Buxus sempervirens suffruticosa.* Magnified 40 times.



Fig. 37. Nematode-infested roots of English boxwood. The "Witches broom" effect results from continuous killing of the young rootlets.

## SELENIUM AND NEMATODES

*The Meadow Nematode*—As has been previously pointed out, the attacking of boxwood plants by root nematodes presents the plantsman with a very serious problem. We have here a microscopic eelworm which feeds, produces eggs and its new generations within the young boxwood roots, and when these roots have died and decayed, persists in the soil about the boxwood plants to attack new roots or those of other types of plants in the vicinity. This pest exists in numerous species but the one which seems to do most damage to boxwoods at the Arboretum has been identified by Dr. G. Steiner, Division of Nematology of the U. S. Department of Agriculture, as the Meadow Nematode, *Pratylenchus* sp. From samples submitted for examination, Dr. Steiner was able to recognize three distinct species of Pratylenchus in roots of English Box and two specimens of Japanese Box growing at the Arboretum.

*Varietal Susceptibility*—From general observation, all forms of boxwood are susceptible to nematode attack. There are indications that the severity of infestation may be related to some extent to growing conditions, certainly to varietal influences. Plants seem less affected in hot dry positions, particularly in the proximity of sod. The coarse-leaved varieties of *Buxus sempervirens* seem least subject to attack, while *B. microphylla japonica* is quite susceptible, and *B. semp. suffruticosa,* the English Box, very susceptible indeed. As mentioned earlier, there is now little doubt that the severe root injury caused by nematodes is responsible for the ill health of many plants of English Boxwood in the Philadelphia district. Such injury not only impoverishes the plant through restriction of water and food supplies but in so doing renders it a ready prey to pest and disease attack, to winter injury, summer drought and any other adverse conditions.

*General Controls*—Nematodes enter the roots of newly set boxwoods (and other plants which are similarly attacked) from the soil. The first step toward preventing such trouble would be

to thoroughly sterilize the soil before planting, and for this purpose such chemicals as DD mixture, or methyl bromide, properly applied, are quite effective. Such treatments are already standard practice for many crops including roses, particularly in the southern states. Both these chemicals, however, must be used well before planting for they are toxic to living tissues. Unfortunately, no effective treatment is at present known for established boxwoods which have become subject to attack. However, the problem is now under active investigation at more than one experiment station so that it is to be hoped a workable solution may soon be forthcoming.*

*The Use of Selenium*—The seriousness of the nematode problem at the Arboretum became fully recognized two years ago. The double rows of English boxwood flanking the main path through the rose garden have been deteriorating for some time, and other specimen plants which had lost their vigor did not respond to feeding and improved cultural conditions as expected. Certain of them, however, have shown improvement in a rather remarkable way following the use of selenium primarily as a control for leafminer and the apparent relationship of this fact to the problem of root nematodes provides reason for the present discussion.

Reference has been made to a selenium treatment of 1 gram per square foot to nursery-grown plants of *Buxus sempervirens rotundifolia* on April 11, 1946. This application effectively controlled leaf miners and mites on the treated plants. One year later, in April 1947, additional pairs of plants of the same variety variously received applications of ¼, ½ and 1 gram sodium selenate per square foot. Pairs of untreated individuals separated each treatment within the row. It has been noted that the weak treatment of selenium did not give complete control of leaf miner, but in spite of this, all treatments had an evidently beneficial effect so far as growth and coloration of the plants were concerned. The foliage became a glossy dark green and the general appearance was that of an excellent response to fertilization—something which could not be accounted for on a basis of mere control of leaf-feeding insects. Untreated plants did not show this response. They remained in a relatively weak condition and during the past cold winter were injured so severely that three of these checks were killed outright and the remainder are still in very sorry condition. All selenium-treated plants survived the 1947-48 winter practically unscathed. A possible clue to this behavior is found by examination of the root system. In July of this year roots of the check plants, when not completely dead, were very heavily infested with nematodes. Practically no uninfested white feeding roots could be found. The roots of all selenium-treated plants, on the other hand, were for the most part straight growing, healthy and vigorous. They were not entirely free of nematodes, but infestation was not of serious proportions and the number of killed rootlets was relatively small. There was every appearance that selenium had been effective in controlling the nematode population and in so doing had restored to these particular plants their normal vigor and their normal winter hardiness.

Figure 38 illustrates another instance of the same effect, in this case with *Buxus microphylla japonica*. Shown in this figure are two established plants of this variety which in 1946 were entirely similar in appearance. Neither was making very good growth and both were badly infested by both leaf miner and boxwood psylla. One of them was treated with 1 gram of sodium selenate per square foot in April 1947. In July of the present year the untreated plant had made poor shoot growth; psylla and leaf miner were abundant and the roots were bunched and partially killed by nematodes (Fig. 38-4). The treated plant was entirely free from leaf miner although it had been very sparingly attacked by psylla. Growth was good, however, and the foliage a fine glossy dark green; feeding roots were long, straight and apparently healthy. Again, they were not entirely free of nematodes but the number present was evidently not sufficient to cause much damage. It would again appear that improvement of the plant had probably resulted from the effect of selenium in markedly reducing the nematode population. Similar observations have been made upon established plants of *Buxus semp. angustifolia,* additional specimens of *B. semp. rotundifolia* and *B. semp. microphylla.*

These results, unfortunately, have not been duplicated with the English box, for it is in this variety that nematodes constitute by far the most serious problem. These tests are continuing, however, and during the present season sodium selenate in a wider range of concentrations has been applied to 166 plants of which the majority are *B. semp. suffruticosa.* In the light of the indications of this progress report, it may well be that either concentration, method, or time of selenium application may be the present unknown factors in improved results, especially with the English boxwood.

* A fellowship has been established by the Bartlett Tree Expert Co. for investigation of this problem at the University of Maryland. The holder of this fellowship, Mr. A. C. Tarjan, is working under the able direction of Dr. Steiner, nematologist of the U. S. Department of Agriculture.

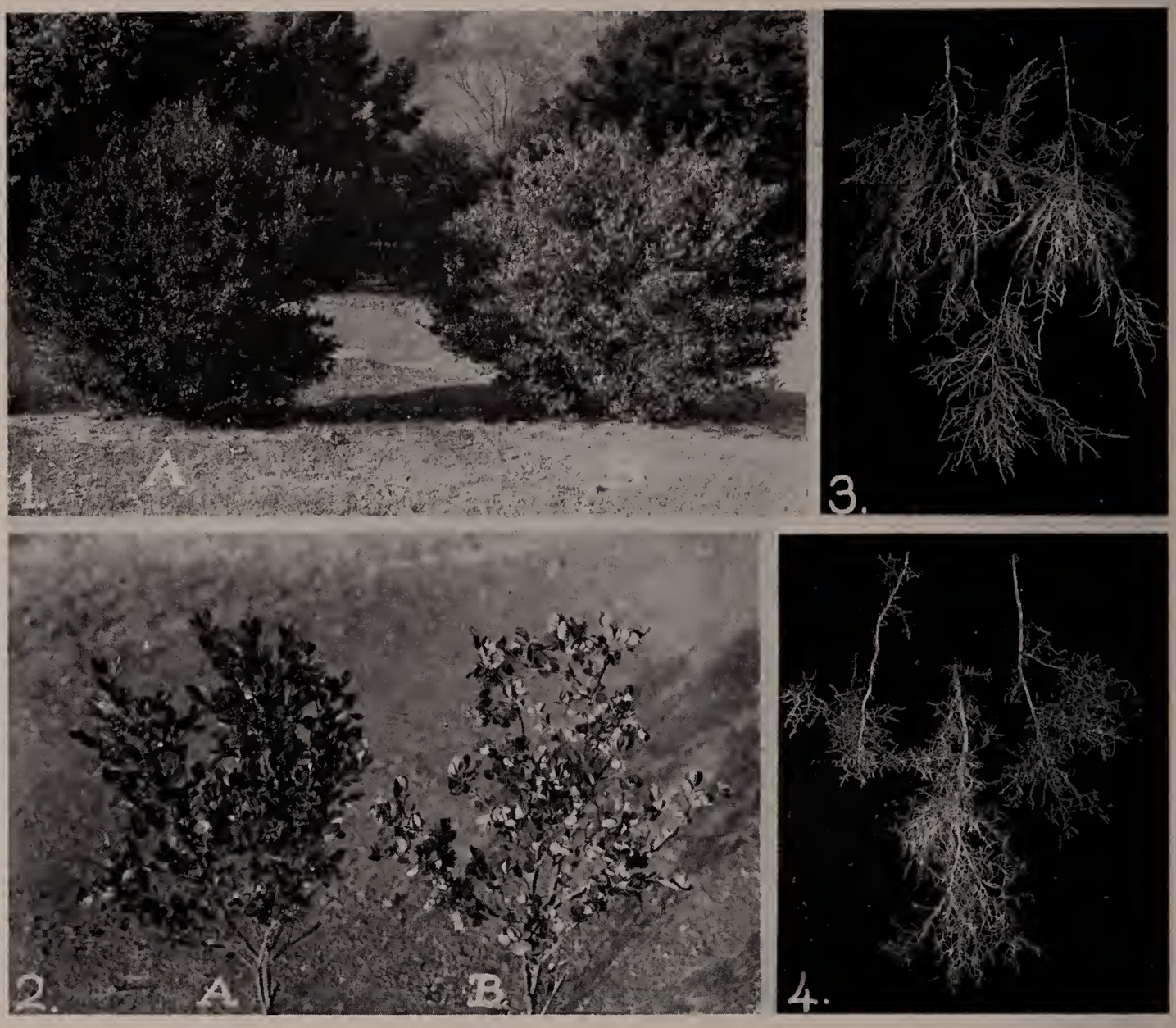



Fig. 38. Effect of selenium upon pest resistance and growth of *Buxus microphylla japonica*. 1A—Vigorous and dark-foliaged plant after spring treatment with sodium selenate. 1B—The untreated plant has sparse foliage of poor color. 2A—Shoot specimens from the treated plant. 2B—Specimen from the control plant; leaves are infested with both psylla and miner. 3—Sample roots from the treated plant (1A) are long, vigorous and comparatively free of nematodes. 4—Roots of the control plant remain typical of heavy nematode infestation.

## GROWTH EFFECTS

It is well known that selenium salts may at times have a stunting effect upon plant growth when they are used in concentrations higher than may normally be needed for adequate control of insect pests. In still higher concentrations they may be lethal to the plant tissues. In view of these facts, it may be of interest to record a few observations regarding the responses of boxwood to selenium independently of the pest control relationship.

Three grams per square foot is the highest concentration of sodium selenate which has been used in these tests. At this strength no deleterious effects have been noted upon healthy roots of strong growing varieties of *Buxus sempervirens* or *Buxus microphylla*. However, a concentration of even two grams per square foot resulted in distinct injury to nematode-infested roots of *Buxus semp. suffruticosa*.

So far as vegetative growth is concerned, it has been noted that such may be increased when the limiting factor appears to be insect attack. However, growth measurements of fifty shoots each of three untreated plants of *B. microphylla japonica* and three plants treated early the same season with one gram per square foot of sodium selenate (all plants being in a quite healthy condition at the start), yielded the following data:

individual untreated plants averaged variously 5.23, 4.35, and 5.55 inches growth per shoot while those receiving selenium averaged 3.02, 3.45, and 3.22 inches. In other words, the shoots of untreated plants in this particular test made an average increased growth of 1.8 inches. Unfortunately enough completely healthy plants have not been available to secure more information on this point but it would appear that a concentration of even 1 gram per square foot may at times have a slightly stunting effect upon growth. It is improbable, however, that such an effect will carry into a second season and when pest control is the primary objective, and adequately secured, a secondary stunting of this nature is more than offset by the benefits resulting from pest reduction or eradication.

## SUMMARY

In this progress report concerning the use of sodium selenate as a control for the pests of boxwood growing at the Morris Arboretum the following principal points have been noted:

1. Water solutions of sodium selenate at a concentration of one gram per square foot of root area are effective in controlling attacks of leaf miner, mite and psylla upon most species and varieties of boxwoods tested.

2. Such an application should be made immediately before growth commences in spring.

3. The useful range of selenate concentration appears to be somewhere between ¼ and 2 grams per square foot. At ¼ gram partial insect control was effected; at 2 grams root injury was observed.

4. Applications of 1 gram per square foot can apparently be effective in so reducing the root nematode populations of weakly growing established plants of certain varieties that normal health, vigor and a pest-resistant condition is almost entirely restored within one year.

5. The English Box, *Buxus sempervirens suffruticosa,* remains an outstanding exception in that sodium selenate cannot so far be considered a satisfactory control agent for either leaf-feeding insects or nematodes.

6. Selenium may have a slight stunting effect upon growth of normally vigorous boxwood plants during the first season following application. Such plants do not, however, appear to be otherwise injured and the effect is adequately offset when pest control is the major consideration.

The above results yield definite indications that selenium salts may find a place in the control of insect pests in certain woody, as well as herbaceous plants. It is to be emphasized that they do not, as yet, provide the solution to the current serious problem of the control of nematodes in the English Boxwoods. Further studies are needed. In view of these facts and in view of the earlier warning that selenium is a poisonous material requiring the utmost care in usage, it is to be emphasized that the indiscriminate use of sodium selenate by home gardeners is at present neither justified nor recommended.

HENRY T. SKINNER

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# Additions to Arboretum Library

The most valuable gift that the Library has received for many years was a collection of 100 or more books, periodicals and pamphlets from the library of Mr. Frank M. Bartram of Kennett Square, descendent of John Bartram. This collection is almost entirely in the field of landscape architecture in which the Morris Arboretum library has been lamentably deficient. Outstanding among the titles included are the following:

AMERICAN GARDENS—Guy Lowell (Bates-Muda, 1902)

AMERICAN LANDSCAPE ARCHITECTURE, 1930-31

ARCHITECTURE AND DESIGN, Vol. III—Olmsted Bros. (1939)

BEAUTIFUL GARDENS IN AMERICA—Louise Shelton (Putnam, 1916)

BOOK OF OLD WORLD GARDENS, edited by A. H. Hyatt (LeRoy Phillips, 1912)

CENTRAL PARK, HISTORY AND DESIGN, edited by F. L. Olmsted, Jr. (Putnam, 1928)

CHARLES ELIOT, LANDSCAPE ARCHITECT—Charles W. Eliot (Houghton Mifflin, 1903)

DESIGN IN THE LITTLE GARDEN—Fletcher Steele (Atlantic Monthly, 1924)

RURAL ESSAYS—A. J. Downing (New York, 1858)

FAMOUS GARDENS—(Country Life Corporation, 1937)

FORTY YEARS OF LANDSCAPE ARCHITECTURE—F. R. Olmsted (Putnam, 1922)

GARDEN MAKING—E. Rehmann (Houghton Mifflin, 1926)

INTRODUCTION TO A STUDY OF LANDSCAPE DESIGN—Hubbard and Kimball (Macmillan, 1917)

JAPANESE GARDENS—Mrs. B. Taylor (Dodd, Mead, 1912)

LANDSCAPE ARCHITECTURE, 1922-1947

LANDSCAPE GARDENING—Beatrice Parsons (Putnam, 1895)

LANDSCAPE GARDENING—F. A. Waugh (Orange Judd, 1912)

THE NURSERY BOOK—L. H. Bailey (Rural Publishing Co., 1894)

OLD GARDENS IN AND ABOUT PHILADELPHIA—J. T. Faris (Bobbs Merrill, 1932)

OLD TIME GARDENS—A. M. Earle (Macmillan, 1906)

FREDERICK LAW OLMSTED, LANDSCAPE ARCHITECT—F. L. Olmsted, Jr. (New York, 1922)

PLANNING YOUR GARDEN—W. S. Rogers (Doubleday, 1923)

PRACTICAL BOOK OF GARDEN ARCHITECTURE—P. W. Humphreys (Lippincott, 1924)

PRACTICAL BOOK OF OUTDOOR FLOWERS—Richardson Wright (Lippincott, 1924)

REPTON ON LANDSCAPE GARDENING—J. C. Loudon (Longmans, 1840)

SIMPLE GUIDE TO ROCK GARDENING—J. L. Cotter (Sheldon Press, 1926)

THEORY AND PRACTICE OF LANDSCAPE GARDENING—A. J. Downing (Moore & Co., 1859)

E. H. WILSON, PLANT HUNTER—E. I. Farrington (Boston, 1931)

## GENERAL ACQUISITIONS

The Arboretum Library has acquired by purchase or by gift within the past two years several useful books and pamphlets including the following titles:

AMERICA'S GARDEN BOOK—Louise and Carter Bush-Brown (Scribner's, 1947)

AMERICAN CONSERVATION IN PICTURE AND IN STORY—Ovid Butler (American Forestry Association, 1941)

AMERICAN TREES—Russell T. Limbach, (Random House, 1947)

BUILDING ESTIMATOR'S REFERENCE BOOK—Frank R. Walker (Walker Co., 1947)

CHECKLIST OF VASCULAR PLANTS OF MAINE—Dr. Fay Hyland (University of Maine, 1948)

CLEMATIS, LARGE AND SMALL-FLOWERED—E. Markham (London, 1935)

CLIMBERS AND GOUND COVERS—A. T. Hottes (DeLaMare, 1945)

CONIFERS IN CULTIVATION—Conference Proceedings of Royal Horticultural Society (London, 1932)

DANISH SPECIES OF ALTERNARIA AND STEMPHYLIUM, TAXONOMY, PARASITISM—Paul Neergaard (Copenhagen, 1945)

DECIDUOUS ORCHARDS—W. H. Chandler (Lee and Febiger, 1942)

DICTIONARY OF PRINCIPAL BOTANICAL AND HORTICULTURAL TERMS—A. M. C. J. Coninck (Stechert, 1926)

GARDENING WITH SHRUBS—Mary D. Lamson (Barrows & Co., 1946)

HANDBOOK OF RHODODENDRONS—(Univ. of Washington Arboretum Foundation, 1946)

HANDBOOK OF TREES OF THE NORTHERN STATES AND CANADA—R. B. Hough (Macmillan, 1947)

HORMONES AND HORTICULTURE—George S. Avery, Jr. (Magraw Hill, 1947)

HORTICULTURAL COLOUR CHART—British Colour Council in collaboration with Royal Horticultural Society (London, 1938)

LIST OF PLANT TYPES FOR LANDSCAPE PLANTING—S. F. Hamblin (Harvard Univ. Press, 1946)

NORTH AMERICAN TREES—R. J. Preston (Iowa State College Press, 1948)

PLANT HUNTERS IN THE ANDES—T. Harper Goodspeed (Farrar & Rinehart, 1941)

PLANT HUNTING IN CHINA—E. H. M. Cox (Collins, 1945)

PLANTING DESIGN—Florence Bell Robinson (Whittlesey House Garden Series, 1947)

PROPAGATION OF HORTICULTURAL PLANTS—Adriance and Bryson (McGraw Hill, 1939)

PROPAGATION OF PLANTS—C. A. Hottes (De La Mare Co., 1945)

REVIEW OF JUNIPERUS CHINENSIS ET AL—P. J. Van Melle (N. Y. Bot. Garden, 1942)

RHODODENDRON YEAR BOOK FOR 1946, 1947—(Royal Horticultural Society, 1946, 1947)

RHODODENDRON YEARBOOKS FOR 1945, 1946, 1947—(American Rhododendron Society, 1945, 1946, 1947

SOURCE-BOOK OF BIOLOGICAL NAMES AND TERMS—E. C. Jaeger and J. Q. Burch (Thomas, 1947)

TREES OF THE EASTERN UNITED STATES AND CANADA, THEIR WOODCRAFT AND WILDLIFE USES—W. M. Harlow (Magraw Hill Co., 1942)

THE HARDY HEATHS—A. T. Johnson (Gardeners Chronicle Ltd., 1928)

WILD FLOWER GUIDE, NORTHEASTERN AND MIDLAND UNITED STATES—E. T. Wherry (Doubleday, 1948)

WOMAN'S HOME COMPANION GARDEN BOOK, edited by John C. Wister (Doubleday, 1947)

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GRAY HERBARIUM
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# Morris Arboretum Bulletin

OCTOBER 1949

Volume 4 Number 10



Fig. 39. BUCKEYE (*Aesculus sp.*)
A good foliaged form at Morris Arboretum.

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# An Unusual Aesculus

The tree of the cover illustration is a specimen of Horsechestnut or Buckeye which has been observed for many years growing upon a property adjacent to the Morris Arboretum. With the purchase of the new administration building the Arboretum has fallen heir to this tree.

As lawn specimens or shade trees the horsechestnuts and buckeyes too frequently have not very much to recommend them. European Horsechestnut is elegant in flower but has a tendency to shed its leaves throughout the summer while those it does not shed are browned by scorch or by the familiar leaf-blotch disease caused by the fungus *Guignardia aesculi*. The best of the native buckeyes are often thin in growth and affected by the same leaf-blotch disease. The odor of flowers and leaves of Ohio Buckeye, *Aesculus glabra,* is not particularly pleasant, and all horsechestnuts present the dubious gift of abundant fruit which litter the surroundings from September on.

The tree pictured is not without this fault; it bears abundant fruit which however ornamental it may be during the summer months is not especially sightly once it has reached the ground. The form of the tree, however, is admirable. Branching is dense for a horsechestnut. Foliage is thick, non-shedding, and of an excellent bright green turning a brilliant orange red in fall; but particularly outstanding is the resistance of this foliage to leaf blotch disease. When all other horsechestnuts in the region are browned beyond hope of recovery, this tree remains conspicuously rich and green. The quality of disease-resistance alone recommends it for propagation and testing on a much wider scale.

The botanical name of this individual has so far defied all efforts at precise determination. Its flowers are greenish white and not so conspicuous as those of the European Horsechestnut, *Aesculus hippocastanum*. The leaflets of its 5 to 7 palmately divided leaves are broader and decidedly thicker than those of Ohio Buckeye, *Aesculus glabra,* which it most closely resembles. Like both of these species its fruits are abundantly, though bluntly, spined. Neither flowers nor leaves have noticeable odor. The tree is a probable hybrid of *Aesculus glabra* while representing a marked improvement over that species.[1] It was thought that seedlings might show variation and afford some clue to parentage. At this date, however, they seem remarkably uniform, though whether they may be equally resistant to

*(continued on page eighty-eight)*

[1] In a recent communication from the Arnold Arboretum Miss L. M. Perry refers to a specimen of this tree as "more like collections of *Aesculus glabra* from Kentucky than any of the hybrids represented in our herbarium."

# The New Administration Building

Frequent visitors to the Morris Arboretum are already acquainted with the new administration building which has been occupied during the past year. For the benefit of friends planning future visits, the new Arboretum Headquarters is situated on Meadowbrook Avenue on the left approach to the main entrance gateway. It stands on a four-acre property immediately adjacent to former boundaries of the Arboretum and will become a more apparently integral part as soon as adjustment of the fence lines can be undertaken.

Since the foundation of the Morris Arboretum in 1933, administration, library, herbarium, lecture rooms, etc., have been housed in the old mansion of the Morris family with which so many of our friends are familiar. Miss Morris, however, expressed the wish that her house should not be permanently used for this purpose. She desired rather that it be either razed or converted, with such structural alteration as would be necessary, to something more resembling a public shelter or meeting place. The means of complying with this request has posed a problem which became increasingly acute with each rise in building costs during the war and post-war periods, for it was impossible to comply with Miss Morris' wish concerning the mansion without first finding adequate quarters for offices and administration.

The residence of "Overlea" was built by Mr. David Pepper in 1893. Just prior to the first world war it passed into the hands of Mr. Russell Thayer and has remained in the family since that time. It became vacant in recent years and was purchased by the Arboretum in 1948. It was evident from our investigation that this property met the needs of an administration headquarters in an almost ideal way. The building is well constructed and the light and airy interior is well arranged for present needs, with space to spare for future expansion; its location is most convenient and the surrounding grounds form a natural continuation of the planting areas of



Fig. 40. The new Administration Building with the drive from Meadowbrook Avenue.



Fig. 41. Upper Left: Thomas Sovereign Gates Hall from the southwest. Upper right: the entrance hall, looking toward the library. Lower left: a view in the library reading-room. Lower right: a corner of the herbarium with its curator, Mr. J. W. Adams.

the Arboretum. Occupation of this building during the past year has served only to increase appreciation of the good fortune which, at minimum expense, has initiated such a satisfactory solution of a problem with which the Arboretum has been faced for so long.

The main entrance of this building opens into a central hall with dark wood panelling and beamed ceiling which serves well for accomodation of the general office. To the right of the hall is a lecture room seating about thirty, while to the far end, past the main stairway, is a pleasant library-reading room, with green walls and white woodwork; a small stack room is beyond. Also on the ground floor is one of the larger offices devoted to the work in Forest Genetics with a small laboratory adjoining. The second floor accommodates four offices, washrooms, etc., and, in a large room at the west end, the herbarium. Like the hallways and stairs, this room has been surfaced with asphalt tile and is well illuminated with modern fluorescent lighting. A third floor comprises four large rooms and an additional bathroom. These at present are used for storage purposes but will be available in the future for expansion of office and study space. A spacious basement containing five rooms underlies the entire building. One of these rooms is now used as a shop for making such things as labels and signs. It is expected that eventually the rest of the space will be used for a laboratory, dark-room, and such other facilities as are at present still housed in the Morris mansion. Hot water heat is provided by an oil-burning furnace.

The new administration building is situated at the top of a steep rise terminated at the lower end by the Scarlet Oak Avenue of the Arboretum proper, and pleasant views are to be had from the terraces over the lower ground and south across the Arboretum to the hill known as Sugar

Loaf beyond Germantown Avenue. Two smaller structures, a four-car garage and a "studio," are part of the property. The latter is of good size, with separate heating system, and may serve a useful purpose as classroom or headquarters for some of the school instruction groups.

In the acquisition of this property, as in other issues too numerous to mention, the Morris Arboretum has been indebted to the constant interest and support of the late Dr. Gates, Chairman of the University of Pennsylvania. It was doubly unfortunate in this case that his death should have occurred before the fruits of his interest were realized. In his honor, and with the gracious permission of Mrs. Gates, the new administration building will be known henceforth as Thomas Sovereign Gates Hall.

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# Plant Acquisitions and Planting

During the years 1948 and 1949 approximately 1578 different kinds of plants have come to the Arboretum greenhouses and nurseries: 93 were of sufficient size to go directly into Arboretum plantings. The majority of the 776 seed packets received were requested on an exchange basis from arboreta and botanic gardens. Several Forest and Range Experiment Stations on the West Coast (Arizona, Montana, Wyoming, Utah, Washington and California) were most cooperative in sending seeds gathered from high altitude plants for tests of hardiness and adaptability in the East.

Many of the small plants received were azaleas and rhododendrons from the U. S. Bureau of Plant Introduction, from Mr. Joseph Gable of Stewartstown, Pa., Bobbink and Atkins Nurseries of Rutherford, New Jersey, and the Tingle Nursery Company of Pittsville, Md. Mr. Henry Hohman of the Kingsville Nursery sent an interesting group of named Japanese maples. With the encouragement and assistance of the American Holly Society, Mr. H. Gleason Mattoon and others, the American, English and Chinese hollies now growing at the Arboretum have been increased to more than 100 species and varieties.

From our own nurseries 1840 plants have been moved to their permanent locations in the Arboretum.

New developments during these years were the Baxter Memorial Overlook, the extensive azalea plantings along the edge of the lower Hillcrest Meadow, clearing and seeding of the slope below the new administration building, the Fraxinus collection near the Wissahickon bridge, the poplar collection near the old mill, partial dredging of the future Cypress Swamp, a new collection of cotoneasters, and the planting of over 60 named varieties of narcissus. Thousands of bulbs, given by the Arthur Hoyt Scott Foundation, were planted in sweeping masses around the rose garden, the log cabin and the spring house by high school boys who have come regularly to gain practical experience as part of their agricultural courses.

An appreciable number of plants were added to the evergreen collections around the Hillcrest and Meadowbrook gates and to the plantings at Bloomfield Farm. Slowly the pictures planned for these areas are taking shape.

*Bloomfield Farm Area:* A few of the additions to the young oak plantings include: a unique 10-foot specimen with a dense globular head called *Quercus palustris* Meehan's Globe, from Mr. Thomas Meehan of Plymouth Meeting; an 8-foot seedling from the giant White Oak, *Quercus alba,* in Wye Mills, Maryland; a Basket Oak, *Q. prinus,* from the Morton Arboretum; a native Scrub Oak, *Q. ilicifolia,* from Andorra Nurseries; *Q. texana,* a native of Texas, sent by Charles C. Deam, of Bluffton, Indiana; and a native of Asia Minor, *Q. haas.*

In the northwest corner of the Farm were planted six *Pinus densiflora,* early-fruiting seedlings selected by Dr. J. W. Wright, Forest Geneticist, and given by Andorra Nurseries.

In the future seashore planting area were grouped ten Table Mountain Pines, *Pinus pungens,* and two Scrub Pines, *P. virginiana,* from the Standing Stone Experimental Forest.

In the meadow south of the barn and along the creek, particularly around the Northwestern Avenue bridge, 28 ash trees were set out. Eight of these are tetraploid and hexaploid plants of *Fraxinus americana* given by Dr. Wright; one is a *F. holotricha,* native to the Balkan Peninsula, sent to the Arboretum from the U. S. Department of Agriculture. The remainder were raised from seed from Cologne, Leyden, Ottawa, Warsaw, the Arnold Arboretum and the New York

Botanical Garden. The two *F. excelsior monophyllum* from Warsaw, Poland, are probably the most unusual ash trees in the Arboretum with their undivided entire leaves. Two *F. velutina toumeyi,* known to serve well for street trees in the dry southwest where they are native, were placed near the road to the miller's house. A group of the Blue Ash, *F. quadrangulata,* valuable as timber trees, native in the mid-west, were planted above the future cypress swamp.

*Planting near Meadowbrook Gate:* Two of the more unusual evergreens added near the Meadowbrook Gate are a small Limber Pine, *Pinus flexilis,* given by the Soil Conservation Service of Colorado, and a blue Lawson Cypress, *Chamaecyparis lawsoniana glauca "Kooy"* among the low junipers bordering the path to the Morris Overlook. For lightness and color eight flowering trees were set out among the evergreens on this hilltop: three magnolias including *M. denudata* of Central China, a gift from the Ambler Nurseries; and two *M. soulangeanas;* a Japanese Witchhazel, *Hamamelis japonica,* gift of the Moore Nurseries in Narberth, Pa., a Weeping Cherry; a Chinese Red-bud from the Soil Conservation Service of North Carolina; a large-flowered, selected form of the Southern Fringe Tree, *Chionanthus virginicus;* and a Sourwood, *Oxydendrum arboreum,* a small native tree that is decorative the year round.

*Rose Garden:* Four varieties of the Saucer Magnolia, *M. soulangeana,* were planted around the upper side of the rose garden to give early color before the blaze of the rock wall reaches its height.

*Hillcrest Avenue:* An attempt has been made at the Hillcrest entrance to accent the slope of the land with sweeps of procumbent junipers and groups of tall, spirey arborvitae, with here and there, to give body to the planting, a full fat pine or winter-flowering shrub. With the 1948-49 additions, this planting really begins to hang together, and a formerly dull area offers much of interest. There is a fairly good collection of procumbent junipers here: *Juniperus chinensis alba, J.c. japonica, J.c. communis depressa, J. conferta, J. horizontalis alpina, J.h. plumosa,* and *J. sabina tamariscifolia.* The majority of these were gifts from Swarthmore College.

Three dwarf spruce and a few Warty Barberries, *Berberis verruculosa,* give interesting contrast among the low junipers as well as repeating somewhat the form of the Japanese maples and the big knob of a boulder at the edge of the road.

Among the other evergreens set out last season are: three hemlocks given by Mr. Charles F. Jenkins: the fine-needled variety of the American Hemlock, *Tsuga canadensis Jenkinsi;* the Western Hemlock, *T. heterophylla;* and the bright green, large-needled Chinese Hemlock, *T. chinensis;* there are pendulous and pyramidal forms of the Chinese Juniper, two plants of *J. mexicana,* a Formosan juniper, and many varieties of arborvitae from Col. Montgomery, Cos Cob, Conn.: *Thuja occidentalis alba, aurea spicata, Boothi, Buchanani, densiforma,* Dorset Yellow, "DT#2," *pendula* and *recurva.*

For winter or very early spring flowering there are two of the small-flowered yellow dogwoods, *Cornus mas* and *C. officinalis;* the fragrant Wintersweet, *Chimonanthus praecox;* and near a group of early, pale magenta azaleas is a hybrid Winterhazel, *Corylopsis,* given by Mr. Henry duPont; the new large-flowered *Forsythia* Spring Glory, gift of the Wayside Gardens, a Japanese Witchhazel and its variety *Hamamelis japonica flavo-purpurascens* from Moore Nurseries; one of the early fragrant honeysuckles, *Lonicera standishi lancifolia* from the Rochester Parks; and a number of willows: the big Catkin Willow, *Salix gracilistyla,* the Goat Willow, *S. Caprea,* and a rare fastigiate willow which forms a slender small tree.

*Azaleas:* Along the upper end of Oak Avenue and circling around through the chestnuts and old lilacs, long beds were dug deep and enriched with leafmold, peat and sludge in the winter. In spring 1948, when the five-to-six foot Japanese Azaleas, *Rhododendron japonicum,* were in full bloom, 260 of them were moved from the nursery into these beds. Their colors ranging from pale pinks through yellow pinks to orange pinks, were blended and mixed so that as one walks through them their beauty arouses anew an appreciation of nature's endless variations and possibilities. Almost ten years ago Mr. Henry Skinner selected the parents, made crosses, gathered the resulting seed, and from them raised these plants. He has selected the best of them as parents for oncoming generations.

For scattered shade on future azaleas, a number of trees were planted in the area northwest of these beds; two magnolias, the early fragrant *M. kobus borealis,* and the Cucumber Tree of the uplands, *M. acuminata; Betula pubescens;* a White Oak; several hemlocks; and the Chinese Wing-nut, *Pterocarya stenoptera.* For occasional shade in the long beds there are: a birch, *Betula papyrifera cordifolia;* the feathery fine-foliaged Honey Locust, *Gleditsia triacanthos;* two of the graceful Sourwoods, *Oxydendrum arboreum;* a Pitch Pine, *P. rigida;* the decorative Flowering Ash, *Fraxinus ornus;* and a Cedar of Lebanon. To flank the beds a score of native rhododendrons, *R. maximum* and *R. catawbiense* have been planted along Oak Avenue.

*The Baxter Memorial:* In 1947 the Germantown Horticultural Society proposed the gift of a brick overlook to be built at the Arboretum in honor of the late Samuel Newman Baxter, horticulturist of Fairmount Park and the Society's President for seventeen years. With the help of the Arboretum the circular brick overlook and its planting were completed for dedication ceremonies on June 5th, 1948. In a recess of the low balustrade is a durable cypress bench with a fitting inscription. The overlook is placed at the intersection of two paths, one to the rose garden through the orchard and the other leading up to the big hill through the viburnum collection. From the overlook there are several pleasing views: along the valley to a graceful large wild cherry, across the same valley through the spires of the tall swamp cypresses to the upper end of the Hillcrest evergreen collection, or across the varied greens of the Japanese garden to the gray beauty of the Himalayan Pine. The tall Silverbell trees, *Halesia monticola* and *H. diptera,* and the old crabapples give a feeling of enclosure. Several varieties of named American hollies are still to be planted for additional background to the overlook. Close by the south side a small ginkgo tree will form a future canopy for shade. Most of the low-growing cotoneasters from the large collection given by Princeton University border the path leading down from the overlook. As many as possible of Mr. Baxter's favorite plants have been used. Colonel George Woodward gave the beautiful specimens of English Boxwood, *Buxus sempervirens suffruticosa,* flanking the entrances. The border of Boxwood accenting the large silverbell trees that frame the entrance are the dwarf form of the Korean Box, *B. microphylla koreana.* Plants of the tiny-leaved form of Boston Ivy, *Parthenocissus tricuspidata Lowii,* given by the Moore Nurseries, are climbing up one balustrade post. On another post is the rarely seen *Decumaria barbara,* a climbing shrub native in our southern states. In a warm protected spot is a small plant of the evergreen Bull Bay Magnolia, *M. grandiflora.* If it thrives, it will be trained along the balustrade in the hope that its flower will scent this whole area. The strong pattern of its leaves and of the *Vitis coignetiae* should give a needed contrast to the predominantly fine textures of the rest of the planting. It is gratifying to see people enjoying this overlook—for its planting and significance, for visiting with one another, or just for resting in the quiet of the arboretum.

MARGARET A. LANCASTER

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# Notes from the Laboratory

## SOME ANOMALOUS FIR FLOWERS[1]

In fir as well as in other conifers, the male and female flowers are separate. Bisexual flowers, containing both male and female tissue, are sufficiently rare to excite interest.

During the 1947 breeding season, a Nikko fir (*Abies homolepis* Sib. and Zucc.) on the Morris Arboretum produced one bisexual flower in the lower portion of the crown. It was about the same size as the purely female flowers. The lower two-thirds consisted of female tissue, whereas the upper third was male.

The same season, a Greek fir (*A. cephalonica* Loud. var. *Apollinis* [Link.] Beiss) produced two bisexual flowers. Both were borne in the upper portion of the crown, as were the purely female flowers. As in the Nikko fir, these were the same size as the purely female flowers. The female tissue was in a collar about three-fourths of the way up the cone, and in a little patch at the very tip; the remainder of the flower was entirely male.

In both species the transition from male to female tissue was abrupt, there being no intergrades between the two types. Thus, the flowers were similar to that reported by Ferre[2] in *Picea montigena,* which was male at the bottom and had a small amount of female tissue at its very tip.

The flowers were picked just prior to anthesis. Hence it is unknown whether the male and female tissues would have performed their normal functions. However, the anthers appeared normal and apparently would have produced good pollen. Since only 1 of 7 and 5 of 80 normal female flowers matured on the Nikko and

[1] The observations recorded here were made in conjunction with the tree-breeding program of the Northeastern Forest Experiment Station, U. S. Forest Service, in cooperation with the Morris Arboretum of the University of Pennsylvania.

[2] Ferre, Y. de Quelques anomales de structure chez les Abietinees. Bull. de la Soc. d'hist. Nat. de Toulouse t. l, v. r, artl. 9, 12 pp. 1946.

Greek firs respectively during 1947, it is doubtful whether these partially female flowers would have set seed.

A careful check in 1948 failed to reveal any bisexual flowers on these or other firs used for breeding, although flowering was heavier than in 1947.

Another peculiarity of the Nikko fir tree should be mentioned. It bore normal female flowers within 7 feet of the ground (some of these matured seed in 1948) in both seasons. Indeed, only half its cone crop is in the very tip of the crown, the other half being scattered over the entire periphery of its 25-foot-tall and 25-foot-wide crown. All other species of firs bear cones only at the very top of the tree. Since this was the only flowering Nikko fir available, it is unknown whether this type of flower distribution is a peculiarity of this tree or of the whole species.

JONATHAN W. WRIGHT,

*Geneticist, Northeastern Forest Experiment Station*

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## A USEFUL POSSESSION

The attention of our readers is drawn to a very useful reference book, *The Directory of Arboretums and Botanical Gardens* published by the American Association of Botanical Gardens and Arboretums, of which association the Morris Arboretum is a member.

Besides detailed descriptive information concerning every arboretum and botanical garden in the United States and Canada, the directory contains an authoritative article on how to establish an arboretum or botanical garden, as well as maps showing arboretum locations, hardiness zones, etc., and a portfolio of photographic illustrations and line drawings of gardens past and present. An alphabetical grouping of these gardens by states and towns makes this an invaluable handbook for travelers of the highway who like to pause here and there for horticultural refreshment. This latest edition of the Directory was published in 1947, but a limited number of copies are still available at a price of $1.50 from The Morton Arboretum of Lisle, Illinois.

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## AN UNUSUAL AESCULUS

*(continued from page eighty-two)*

leaf-blotch is yet to be determined. Such uniformity does not necessarily dispel the theory of hybrid parentage in view of the fact that the Red Horsechestnut, *Aesculus carnea*, although of proven hybrid origin, is a tetraploid which breeds perfectly true from seed. A horticultural name will doubtless be called for if progeny of this particular buckeye or horsechestnut make as good a showing under future testing as has the original during its probable 40 or 50 years of existence.

HENRY T. SKINNER



Fig. 42. Fruit and foliage of the hybrid (?) *Aesculus*. Fruit spines are well developed for *Aesculus glabra* but are not as long or pointed as those of *A. hippocastanum*.

GRAY HERBARIUM
FEB 4 1950
HARVARD

# Morris Arboretum Bulletin

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Fig. 43. LEATHER-LEAF VIBURNUM
*Viburnum rhytidophyllum* Hemsl.

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# The Leather-Leaf Viburnum

Berries and fruits have been generally abundant on many kinds of woody plants this year. When this happens after a series of comparatively mild winters it seems that certain plants put on a show of which we scarcely dream them capable. A present example is the Leather-leaf Viburnum, *V. rhytidophyllum,* of the cover illustration.

For those who are unfamiliar with the Leather-leaf or Evergreen Viburnum, it is a plant with stiffish ascending branches reaching a height of nine to twelve feet with a spread of about the same dimensions. The optimum eastern range is from New York City south, and within this range it is fully evergreen. With less luxuriant growth and shedding much of its foliage, it is reasonably successful in protected spots as far north as Boston and up-state New York. The rather ornamental flower-bud clusters of this viburnum are formed in autumn and, like the leaf undersides, are covered with a cinnamon gray tomentum. They open in mid-May as large heads of yellow-white which, though interesting, are scarcely showy. Upper sides of the five to nine inch long leaves are a glossy dark green and deeply furrowed. Actually, they seem dark green only on dull days or in shadow. In bright sunlight reflections from these uneven leaf surfaces result in a predominantly gray effect. Stems and older branches are dark gray to almost black.



Fig. 41. Fruit and foliage of the Leather-leaf Viburnum.

Leather-leaf Viburnum has marked personality and character. Perhaps for this reason its qualities are as much praised by some as they are depreciated by others. It may be significant that

*(continued on page ninety-seven)*

# A Lath House Built For Durability

A new lath house or "shade house" has given excellent results at the Arboretum during the past two seasons for growing on young azaleas, rhododendrons and other plants which respond to partial protection from sun and wind during their earlier stages. Since completion of this house in early 1948 several requests for construction details have been received. The following notes may provide helpful information for others who contemplate erecting a structure of this kind.

In the planning stages of this particular lath house essential needs called for some type of suitable permanent shading for a big enough area of ground level beds to accommodate approximately 5,000 plants at 6-7 inch spacing. Since a shaded area might also on occasion be needed for a few relatively tall plants, it was desirable that headroom should not be too restricted. The preferable location for such a structure was an eighty-foot length of gently sloping hillside adjacent to a partially sunken greenhouse in the propagating area. This, however, is a conspicuous position so that appearance as well as serviceability became a necessary consideration. Inevitably, of course, arose the question of economy. This was to be a permanent structure, and on this basis it was judged to be exceedingly poor economy to use either mediocre materials or dubious construction methods in the production of something which might serve for perhaps ten years (with a repetition of the initial investment at the end of that time) if a 25 or 50% greater initial outlay could give serviceability for twice as long. Avoiding extravagance, it was agreed that real economy lay in utilization of the best possible materials which could readily be found and the soundest construction methods which could be adapted to the purpose in hand. It is believed that these requirements have been met in very fair measure so that, although predictions are more suited to the radio than to arboretum bulletins, it is felt that the life expectancy of this house as completed should be at least 30 to 40 years. It is hoped it may be longer.

With the above considerations in mind a peak or span roof structure seemed to best fulfil the requirements as well as to fit, in appearance, with the similar lines of the nearby greenhouses. A tentative model for such a house was found in a number of span roof lath houses erected by the Department of Floriculture at Cornell University in 1931. Design of these houses was based upon utilization of 12-foot, 2 x 4 inch lumber with standard plasterers' lath applied in 4 x 4 foot sections. Their 20-foot width allowed for a central planting bed 6 feet wide, two 2-foot walks and side beds of 5 feet each. 4 x 4 inch supporting side posts were set in concrete, and 2 x 4 inch ties, nailed, were used to prevent spread of the rafters. In the case of these houses it has been interesting to note that during a heavy snowstorm ten years after construction the side posts and the nailed ties proved to be the weakest point. The side posts rotted at soil or concrete line and the ties pulled from the rafters, resulting in the collapse of at least one of the units. The 20-foot width and general layout of these houses met requirements at the Morris Arboretum, and the case history of the Cornell experience was valuable in pointing the way to possible improvements in design and construction materials.

In the matter of materials the emphasis was upon durability throughout. Lumber for the supporting posts, the boards surrounding planting beds and the smaller posts to which they are secured must all withstand contact with moist soil. Probably there is no wood available in the Eastern United States which is more likely to last under such conditions than Long Island Shipmast Locust *(Robinia pseudoacacia* var. *rectissima)*. Fence posts of Shipmast Locust 110 years old have been re-sold for further use at 50c apiece! At a 50-year life expectancy it still could probably not be equalled by any other type of lumber. The construction of greenhouse benches with Shipmast Locust was described in an earlier issue of the *Bulletin* (IV:3:1942). In spite of extreme conditions of temperature and moisture, these benches are standing extremely well after eight years.

For the lath house 6-inch by 8-foot Shipmast Locust posts and 8 x 1¼ inch locust boards were brought from Long Island. An entire structure of locust would undoubtedly have been durable but unfortunately it is impossible to secure clear lumber in 12-foot lengths suitable for 2 x 4's; moreover in these thicknesses it is subject to warping. The next preference in durable lumber for use above ground was southern Swamp Cypress *(Taxodium distichum)*. All 2 x 3's, 2 x 4's, 3 x 4's, and lath were accordingly cut from all-heart, tank grade swamp cypress. Stainless steel binding plates were used at junctions of the cross rafters and also for attachment of the tie rods. The tie rod assemblies themselves were of galvanized iron and already the galvanizing has shown up as a weak point. All hardware was of brass, screws and lag bolts being used at all points in preference to nails which, however durable they may be, inevitably raise and loosen

in wood that is constantly subject to changing weather conditions.

In the matter of design no significant changes were made in the original pattern beyond minor modifications to suit slightly different needs and materials. The 20-foot available width was adhered to but the ridge height was increased slightly to make the roof slope fairly comparable with that of the adjoining greenhouses. This necessitated the use of rafters 12 feet 1¼ inches long rather than the standard 12 feet. Had standard lumber been used the same effect could have been obtained by a slight reduction in width. In place of three lines of 2 x 4 purlins for each side, four lines of 2 x 3's were used to afford better support for the single piece laths. Similarly a horizontal lath support was added on each vertical side. Metal tie rods, with turnbuckle ridge supports, were preferred to nailed horizontal 2 x 4's on a fourfold basis of strength, lightness, headroom and appearance.

The accompanying photographs show general construction details of the lath house as completed. Double lath-covered doors were added at each end after these photographs were taken.

*Principal Dimensions:*

Length—78 feet.
Width—20 feet.
Height—12 feet, 3 inches.
Center bed—6 feet wide, 68 feet long.
Side beds—5 feet wide, 78 feet long.
Supporting posts—5 feet 2 inches above ground, 34 inches below, spaced at 6 feet apart. Set in soil only.
Doorways—7 feet high, 4 feet wide .
Lath—1½ inches wide with 1⅞ inch spacing.
Purlins notched 1 inch deep to rafters.

*Materials Required:*

28 locust posts 8 feet x 6 inches.

41 locust posts 3 feet x 5 inches, split to provide 82 stakes for planting beds.

36 locust boards, 8 feet x 8 inches x 1¼ inches for planting beds.

36 locust boards, 6 feet x 8 inches x 1¼ inches for planting beds.

13 cypress pieces, 3 x 4 inches x 12 feet for ridge rafters.

60 cypress pieces, 2 x 4 inches x 12 feet 1¼ inches for rafters and plates.

104 cypress pieces, 2 x 3 inches x 12 feet for purlins and door supports.

17 cypress pieces, 1 x 2 inches x 12 feet for side and end lath supports.



Fig. 45. The completed lath house before final grading or addition of doors.



Fig. 46. Interior of the lath house showing construction details.

1002 cypress lath, 1½ x ⅜ inches x 12 feet 2¼ inches.
136 pieces stainless steel, 16 gauge, 6 x 1¼ inches, punched 4 holes.
48 pieces stainless steel, 10 gauge, 2 x 9 inches, punched 3 holes.
12 pieces stainless steel, 10 gauge, 6 x 1¼ inches, punched 3 holes.
12 galvanized tie rod assemblies. Rods ⅝ inches by 18 feet 8 inches.
24 galvanized bolts, ⅝ x 3½ inches, with nuts.
130 brass ½ x 4 inch lag bolts with washers.
525 brass ¼ x 2½ inch hex head machine bolts with nuts.
85 gross brass #4, 1¼ inch flathead wood screws.
2 gross brass #12, 2 inch flathead wood screws.
3 gross brass #12, 3 inch flathead wood screws.

In the matter of lath spacing it will be observed that laths 1½" wide were set at 1⅞ inches apart. The amount of shade afforded by this spacing seems about right for this region. A spacing equal to or less than lath width gives too much shade for promotion of normal growth. No wood preservatives were used and no coloration was required; the cypress has already weathered to a pleasing silver gray. With construction completed the three planting beds were provided with tile and cinder underdrainage. Water faucets were installed at the center point of each walk. The walks were filled with cinders and the beds with prepared soil well enriched with Michigan peat. At the time of construction it was anticipated that it might be necessary to control drip from the purlins. Drip effects have not, however, been serious even in heavy rains. Possible improvements or changes to this structure may suggest themselves with longer usage. The installation of diagonal tie rods from ridge rafter to plates at each end of the house seems advisable, for instance, to prevent any lengthwise wind rack which might possibly develop. In all principal aspects, however, the shade house meets requirements very satisfactorily.

Henry T. Skinner

# Notes from the Laboratory

## METASEQUOIA IN ITS SECOND YEAR

The first shipment of seeds of the recently discovered Dawn Redwood, *Metasequoia glyptostroboides,* was received from Dr. Merrill of the Arnold Arboretum on January 22nd, 1948. These seeds were sown in April 1948, some in the greenhouse, others in open beds outdoors. Germination was reasonably good in both locations, and comments regarding growth characteristics of this highly interesting tree have been previously published.[1] The seedlings that germinated outdoors attained a height of about twelve inches the first season. They remained outdoors and, with no protection whatsoever, withstood the relatively mild winter with no apparent injury.

The present note draws particular attention to the growth rate of these plants during 1949. At cessation of growth in October the tallest plant measured five feet nine inches in height, forty-five inches in spread and had a stem diameter of one and a half inches at two inches above ground. The height growth during one season has been fifty-seven inches! Neither related Swamp Cypress *(Taxodium distichum)* nor Redwood *(Sequoia sempervirens)* have been observed to equal this performance in the Philadelphia region. Dawn Redwood should make a large tree quickly if such growth rates are maintained.

These outdoor specimens give every indication of satisfactory ripening and of uninjured passage to a dormant winter condition in spite of the lateness of growth completion. Trees that were retained in pots have remained relatively small.

HENRY T. SKINNER

[1] Skinner, H. T. Growth habit of Metasequoia. Gard. Chron. 125 (3239):44.



Fig. 47. A *Metasequoia* sixty-nine inches high at the age of eighteen months.

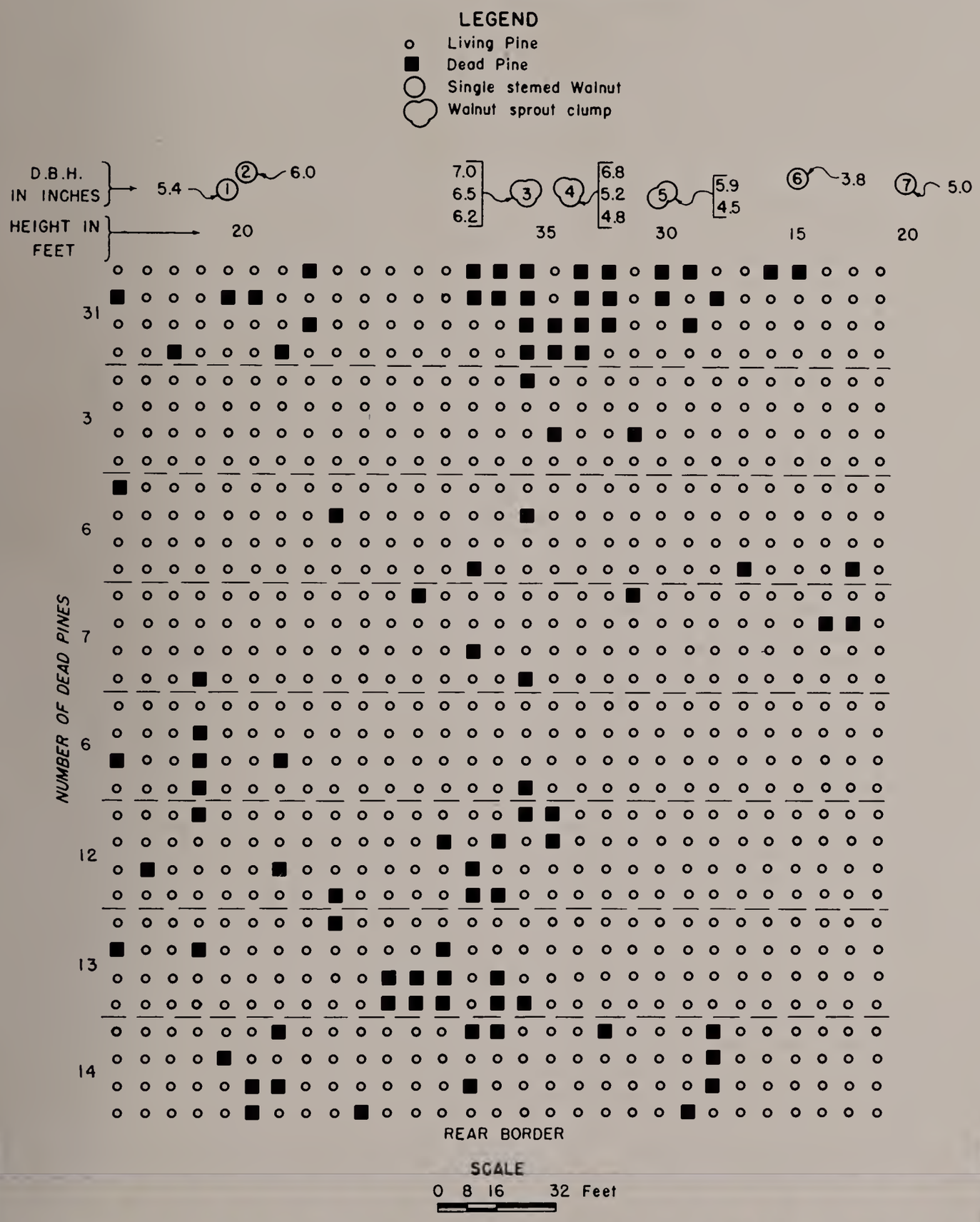
## CAN BLACK WALNUT POISON PINES?[2]

Black walnut trees have been reported to kill or severely stunt a number of plants including tomatoes, potatoes, alfalfa, cabbage, rhododendron, apples, quince and some varieties of cherry. Chemical studies have shown that such injury is probably due to a chemical substance *juglone,* which is given off by the walnut roots and is highly toxic to some plants.

About 1926, while motoring through central New York, I saw a small forest planting in which black walnut and Scotch pine had been planted in alternate rows at a 6 ft. x 6 ft. spacing. Practically all of the pines had died but since I had no information on the early history of the plantation, particularly on the condition of planting stock and on planting methods, the walnut trees could be suspected but hardly indicted. Now a rather convincing case of pines killed by black walnut has become apparent in one of our plantations of pedigreed trees near State College, Pa.

[2]) The observations recorded here were made in conjunction with the tree-breeding program of the Northeastern Forest Experiment Station, U. S. Forest Service, in cooperation with the Morris Arboretum of the University of Pennsylvania.

# MAP OF PINE PLANTATION SHOWING BORDER EFFECT OF BLACK WALNUT




U. S. DEPARTMENT OF AGRICULTURE · FOREST SERVICE
NORTHEASTERN FOREST EXPERIMENT STATION

The present case against the black walnut is presented in the plantation map and requires only a few words of explanation. Progenies of Scotch, Norway, Austrian, Japanese red and Japanese black pines, and hybrids between these parents, were planted in the spring of 1945 (at 8' x 8' spacing) in a reasonably uniform sodded field. The "front" and "rear" borders were planted with Japanese red pine from a single mother tree; the rows of pedigreed progenies were planted at right angles to these borders.

The front of this plantation was set back 24 feet from a row of 7 small black walnut trees. The diameter at breast height (D.B.H.) and the maximum height of the trees (numbered 1-7) are listed on the map.

In the fall of 1948, after 4 growing seasons, survival was slightly over 90 percent and most of the pines were growing normally. Mortality varied throughout the plantation but the heaviest losses were in the vicinity of walnut trees Nos. 3, 4, and 5. These were sprout clumps 30-35 feet in height. The killing effect of these trees appears to extend outward in a semicircle with a radius of at least 42 feet. The twenty or more living pines within, and bordering, this semi circle, are far below average height and are in noticeably poor condition. Walnut trees Nos. 1, 2, 6, and 7 are smaller, and up to the present, although they do not show any definite "killing zone", they apparently have retarded the growth of adjacent pines.

Strips 4 trees wide, parallel to the walnut row and at right angles to the progeny rows, provide a series of 8 comparable sample areas. The number of dead trees in each of these transect strips is recorded on the left of the map. The strip adjacent to the black walnut trees had 31 dead pines, more than twice the mortality in any of the other sample strips transecting this plantation.

Can black walnut trees poison pines? In this instance I think the answer is yes; be careful what you plant near your black walnut trees.

E. J. Schreiner

●

# Notes and Personals

The Arboretum welcomes the following new associates: Dr. William H. Erb, of 133 So. 36th St., Philadelphia; Mr. Frederic R. Kirkland, of Old Gulph Road, Wynnewood, a gentleman greatly interested in his hobby of rhododendrons; Dr. Francis Schumann, of Germantown and Mr. Evan Randolph, of Chestnut Hill who knows a great deal about the birds of our area and who has successfully campaigned for the construction of several winter feeding stations to be erected in the Arboretum.

* * *

James Lambert retired from his work as Superintendent of the Botanic Garden and Greenhouses of the Department of Botany of the University on June 30th of this year after 42 years of valuable service. He came to the Department from Kew Gardens in June, 1907. A dinner attended by 35 friends was given in his honor at Houston Hall on May 24th. Mr. Lambert plans to remain in Philadelphia most of the year but expects to do advisory work with a private Arboretum in Lake Worth, Florida, during the winter months.

As successor to Mr. James Lambert, Charles Gordon Tyrrell has been appointed Superintendent of the Botanic Garden and Greenhouses of the Department of Botany. Mr. Tyrrell joined the Arboretum staff as Propagator in February, 1948, coming to us from the gardens of the Royal Horticultural Society at Wisley. He was born in Kent, England, has had considerable experience in the Park Departments of that country, and by reason of his technical skills has proved a valuable addition to the Arboretum. He has assisted with the Horticulture-Agriculture program of the Philadelphia Board of Education, and is already known for his activities among horticultural groups of this area. His time will now be divided between the Arboretum and the Department of Botany.

* * *

The Arboretum and the Arthur Hoyt Scott Foundation were proud to receive the White Ribbon Award of the Garden Club Federation of Pennsylvania for the exhibit of berried trees and shrubs cooperatively staged at the Fall Flower Show of the Pennsylvania Horticultural

Society at Swarthmore, November 4-6. The White Ribbon is a special award for "outstanding horticultural achievement."

* * *

Some of our readers will remember Dr. Schramm's description of two remarkable China Fir Trees growing at Bowling Green, Virginia, which appeared in the Bulletin of November, 1948. Two hundred and fifty copies of this issue were sent to Mayor J. W. De Jarnette who distributed them as a Christmas gift to community residents of Bowling Green, the local press and the Richmond Times Dispatch. Additional copies were put to good use by Dr. I. F. Lewis, Dean of the College of the University of Virginia. There was an imminent threat to at least one of these trees because of proposed building operations. We are happy to report that assurance has been received that all threats to these trees have now been removed.

* * *

A tree identification contest sponsored by the Arboretum created considerable interest at the Conference of Shade Tree Commissioners in Newark, New Jersey, on November 30th and December 1, 1949. The Arboretum also contributed to the programs of the National Shade Tree Conference in Baltimore on August 22-26, the Association of Botanic Gardens and Arboreta, meeting with the American Institute of Park Executives at Detroit on September 20-23, and the semi-annual meeting of the American Holly Society at Rutgers University on November 17-18. The Arboretum has been appointed an official Holly Test Garden for the latter association.

## THE LEATHER-LEAF VIBURNUM

*(continued from page ninety)*

the critics are usually northerners whose plants are probably not too happy. In its proper range we personally feel that it has a great deal to offer as a lawn specimen, for accent or contrast where boldness seems needed, for transition between rhododendron masses and foliage of light texture, for the green garden, or as an all year screen. It likes moist soil and will grow in anything from full sunlight to almost complete shade. As with many woody plants, this species is relatively self-sterile, and two or more seedgrown individuals are necessary for plentiful fruit development. In a good crop year the berries are borne in tightly packed spherical clusters about the size of a tennis ball. (See Fig. 44) At their red stage in mid transition from pinkish green to black these heavy fruit balls are both distinctive and highly ornamental.

There are two named forms of the Leatherleaf Viburnum—one with golden variegated leaves and of questionable merit, the other the variety *roseum* with flowers which are bright pink in bud. This form was exhibited before the Royal Horticultural Society in 1938 and is as yet scarce. When available, its additional spring interest should mark it as the preferred form for general cultivation. Like other viburnums, the seed of this species requires fall sowing outdoors or stratification at a cool temperature. It may be rather slow to germinate.

HTS

Many issues of the Bulletin are now out of print. The return to the Morris Arboretum of any unwanted copies would be greatly appreciated.

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# Morris Arboretum Bulletin

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Fig. 1. BURFORD HOLLY
*Ilex cornuta Burfordi*

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

# The Burford Holly

The cover illustration of this issue will be familiar to Associates of the Morris Arboretum. It represents a larger specimen of the plant selected for distribution this year which it is hoped will thrive in its many new garden homes.

This holly—the Burford Holly—apparently originated as a bud sport of the tall-growing Chinese Holly, *Ilex cornuta,* which was observed, selected and propagated some years ago by Thomas A. Burford, who was Superintendent of the West View Cemetery in Atlanta, Georgia, until his death in 1920. Its bright green color, glossy leaves and stiffish growth are characteristic of the Chinese Holly, but it makes a much denser, broader and lower bush (perhaps 8 to 10 feet high in this region). Its leaves are rounded and bear either three spines or one terminal spine only in place of the three prominent terminal and two strong basal spines of the typical *Ilex cornuta.* The Burford Holly is a female clone which, quite exceptionally among hollies, is able to set good crops of its large red berries parthenocarpically, that is, without pollination. The fruit crop will normally be larger, however, if the open flowers are sprayed with a fruit-setting hormone, or if a male *I. cornuta* is planted nearby. There is, of course, no substitute for pollination if fertile seeds are required.

This holly is a favorite in the southern states but although at present rare there is no reason why it should not be quite satisfactory around Philadelphia provided it is planted in a reasonably sheltered position where winter winds from the North will be at least broken in intensity. Like most hollies it is not particular as to soil so long as a good supply of peat, leaf mold or other organic material is thoroughly mixed in at the time of planting. After the first year a little fertilizer in early spring will not be amiss for speeding growth and giving good deep color to the foliage.

H. T. S.

# Concerning Holly

## THE HOLLIES OF SANDY HOOK

An evergreen, spiny-leaved holly tree makes a fine ornamental for the modern garden, whether it be native *Ilex opaca* or the glossy-leaved *I. aquifolium* of European fame and fable. Fashions change in plants as they do in clothes, and holly is riding an ascendant popularity wave which already bids fair to far outshine its almost forgotten horticultural progress in England at the turn of the 18th century. Reasons for the reawakened interest are traceable to the crusading powers of a few people who have viewed with alarm the progressive depletion of our sources of American holly through a process of unregulated branch stripping for the Christmas market, until demands now far exceed the fast diminishing natural supply. Some of these same folks have also recognized the admirable qualities of the holly tree as a decorative broad-leaved evergreen for the typical small property of today. It possesses all-year interest and has special value in the winter landscape as a specimen or hedge which can also provide indoor decoration at the Christmas season.

Segregation of the better forms of *Ilex opaca* has been as necessary as it was in years past for *I. aquifolium,* and we are already indebted to such pioneers as Miss Elizabeth White of Whitesbog, New Jersey, Mr. Wilfrid Wheeler of Falmouth, Massachusetts, Dr. Harold Hume in Florida and several others for the searching out and the introduction of many forms which are unquestionably superior to the average wildling. From the horticultural standpoint no one deserves more credit for advertising the merits of American Holly as a landscape plant than Mr. Earle Dilatush of Robbinsville, New Jersey, who has let no opportunity slip by of propagating outstanding types and bringing them to the attention of the gardening public.

At the present time the sidelights of interest in this plant are represented by a very active American Holly Society under the chairmanship of one of the country's keenest amateur growers, Mr. C. R. Wolf of Millville, New Jersey. Arboretum collections are being encouraged so that upwards of 200 species and forms in the genus *Ilex* are already to be found growing at the New Jersey Agricultural Experiment Station, and very nearly as many at the Morris Arboretum, another of the Society's test grounds. Several progressive nurseries in the eastern states are now listing a wide selection of varieties, and throughout the month of February this year growing plants of 31 varieties and forms of English Holly were on exhibit at the offices of the Pennsylvania Horticultural Society. This exhibit by Mr. H. Gleason Mattoon is probably the most extensive that has ever previously been staged in this country.

Preceding it, but also accompanying the increasing interest in holly on the horticultural side is the constantly increasing sales volume of cut holly for the Christmas trade. This trade has actually become an industry of very considerable proportions. The familiar "Oregon Holly" of Christmas time is actually English Holly, *Ilex aquifolium,* which has been commercially grown in the holly orchards of Washington, Oregon, and British Columbia. One West Coast grower alone, Mr. Ambrose Brownell of Milwaukee, Oregon, cut 50 tons of Oregon Holly for Christmas shipment to all corners of the United States. Here in the East the greater proportion of cut holly still comes from trees of the farm woodlot, and state conservation agencies are making headway in the encouragement of harvesting practices which may ultimately increase production from this source and overcome, at least to some extent, effects of the ruthless vandalism of the past. Nevertheless, increasing amounts of cut American Holly may be expected from eastern holly orchards, just as Oregon Holly is a product of orchard cultivation.

A reawakening as to horticultural potentialities of holly has rather naturally been accompanied by a sharpening of interest in the future of our reserves of *Ilex opaca* in the wild. These interests, however, are not confined to horticulturists alone. Throughout the regions of its natural occurance from Massachusetts to Florida the holly tree has served a variety of uses since colonial days—inevitably for Christmas decoration and unfortunately also for the excellent firewood it makes. But in addition it has been much used in turnery for tool handles, furniture, etc., and a great deal for ivory white inlay work or dyed as imitation ebony. Then, too, its berries are eagerly sought by birds during winter months when food is scarcest. Because of its varied usefulness to man this plant has been subjected to such indiscriminate cutting and destruction that almost solid holly forests are today represented by only scattered third growth scrub with their largest specimens but a few inches in diameter. In the northeastern states holly forests, in all except a few greatly restricted areas, have no real



*N. J. Dept. Conservation and Development*

Fig. 2. A part of the fine stand of native holly still remaining on Sandy Hook.

semblance of their former size and abundance. In local areas of Cape Cod, which was formerly rich in holly, a fair number of trees still remain, a few of which have diameters of twelve inches or more. Some dense growths of rather stunted trees are to be found on Fire Island and on Long Island as far as Montauk Point, while farther south, on the Eastern Shore of Maryland and Virginia, some majestic hollies with trunks of two feet or more in diameter can be come across with searching.

There is one area, however, apparently almost unknown even to the botanically well informed, where holly may be seen in remarkable size and natural abundance within a relatively short distance from Philadelphia and within actual view of the City of New York. This area is on Sandy Hook, that remarkable sand bar projecting into New York Bay from the Jersey Coast which is best known for its ancient shipping guide, the Sandy Hook Light, or as a name of the daily weather reports.

The first introduction of the writer to the hollies of Sandy Hook was on the occasion of a guided visit last November arranged by the American Holly Society, although it has since been found that an excellent description of this remarkable holly forest by Alden T. Cottrell, Director in the Department of Conservation and Economic Development of New Jersey, was pub-

lished under the title of "Hollies' Northern Outpost" in AMERICAN FORESTS for January 1939. Mr. Cottrell has kindly supplied the accompanying photograph, and with his permission we quote from some of the observations in his article:

"This holly is the principal constituent in what has been classed as the maple-holly forest occupying the oldest dunes on the peninsula, a plant community that begins two miles north of the entrance gate at Highland Beach about midway of Spermaceti Cove. The principal species found with the holly are red maple, red cedar, wild cherry and hackberry, abundant about in the order named. The holly is at its best in a dense patch of woodland covering possibly one hundred acres. Here it makes up about sixty per cent of the stand in number of trees and a somewhat higher percentage in wood volume, but in small areas of a quarter of an acre, it is often found to the exclusion of everything else and then again it may be almost absent. Outside the limits of this hundred-acre tract, it thrives in small patches, bordering Hartshorne Drive and elsewhere occasionally grows as a scattered single tree.

"Besides being abundant, these hollies are notable for their large size. Many of them exceed a foot in diameter, a few are eighteen to twenty inches, and the largest one measured, growing on Hartshorne Drive, is five and one-half feet in circumference. Few trees were found under four inches in diameter. They do not reach unusual heights, the limit for the tallest being about fifty-five feet. Trees a foot or less in diameter are vigorous and thrifty; those over fifteen inches shows signs of maturity and loss of vigor.

"Some of the hollies are very old. It has been reported that it takes a century for a holly to attain a foot of diameter on Sandy Hook. Although in a general way this may be true, it took at least one holly much longer to reach a foot in diameter. This particular tree was selected for boring because its very appearance suggested it has reached a ripe old age. Two feet in diameter at the point where the core was extracted, it is estimated to be 275 years old, estimated necessarily because the borer used was too short to reach the center. The core extracted, 7.3 inches in length, showed 185 annual rings. Inasmuch as there are larger hollies and therefore conceivably older ones, some of them may have witnessed the arrival of Hendrick Hudson when he anchored the Half Moon in Sandy Hook Bay in September, 1609.

"Before the federal government acquired Sandy Hook, the holly was subjected to ruthless vandalism. In some cases whole trees were stripped of foliage. Past abuses have left many of the trees bare of the lower branches which add so much to the beauty and grace of the tree. Nevertheless some very beautiful and shapely specimens greet the lovers of this Yuletide symbol famous in song and story.

"Riding along Hartshorne Drive, the principal highway that runs to Fort Hancock proper, one is struck with the singular beauty of this avenue bordered with hollies for more than two miles. In spots the trees are close enough to the roadway to furnish overhead shade. East of the road the CCC, formerly assigned to Fort Hancock, has made improvement cuttings removing principally catbriar and dead cedar trees from the holly stands. A foot path, Scotland Trail, has been cut through the woods leading straight across the Hook from Hartshorne Drive to the ocean. To the west of Hartshorne Drive the woodland remains untouched, and those nature lovers who revel in undisturbed forest conditions can scratch their legs to their heart's content in the impenetrable thickets of catbriar and tangled vines."

As has been indicated above, Sandy Hook has long been a government military reservation known as Fort Hancock. Admittance of the general public has required application to the commanding officer of the fort and has thus been restricted. This happenstance has been a benevolent one so far as the hollies are concerned for it is evident that army authorities have evinced a commendably considerate trusteeship in their behalf. In case either ownership or administration of Sandy Hook should change, it is to be hoped that the state of New Jersey, with the support of every person who believes in the conservation of our natural resources, will see to it that this unique remnant of our coastal flora will be protected against destruction for all time.

HENRY T. SKINNER

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# Arboretum Exhibit at the Philadelphia Flower Show

Once again the Morris Arboretum staged an exhibit at the Philadelphia Flower Show, March 20-25. In keeping with the aims of the Arboretum, the exhibit was planned on an educational rather than on a purely display basis, around the topic of plant breeding—the modern science which has become "an indispensable tool for meeting the increasing demands of agriculture, horticulture and forestry".

Plant breeding at the Morris Arboretum is

concerned with the improvement of ornamental woody plants, and in cooperation with the U. S. Forest Service, the development of better forest trees. Exhibited were samples of methods and results with rhododendrons for ornamental use and rapid-growing poplars for reforestation.

Using rhododendron species, the techniques of hybridization were demonstrated step by step. The flowering parent plants and their resultant progeny were also there to complete the picture. Color-grouped around this demonstration were hybrids raised at the Morris Arboretum as well as some recent introductions new enough to be unfamiliar to the average gardener, each being marked as to its availability in the trade. Included in this latter group were the Dexter Fortunei hybrids, a relatively new race of hybrids produced on Cape Cod by Charles O. Dexter between 1920 and 1930, intercrosses between such species as *R. fortunei, discolor, decorum, griersonianum,* and *haematodes.* Also included were the new 'Red' and 'Pink Progress' of Roland De Wilde, Jr., as well as the recently introduced Vuykiana Azaleas (see article on p. 7, this issue). Among varieties of this race exhibited were 'Helena Vuyk', 'Beethoven', 'Mozart', 'Sibelius', 'Haydn', 'Gerardina Vuyk', and 'Wilhelmina Vuyk'.

Besides rhododendrons and azaleas, the exhibit included some of the new rapid-growing disease-free poplar hybrids, representing work in forest genetics being carried on by the Northeastern Forest Experiment Station in cooperation with the Arboretum. Eight-foot trees were shown demonstrating one year's growth from a dormant cutting—a small piece of branch 12 inches long and without roots. Even at this early stage some of these trees showed signs of branchiness, others being clean-stemmed. These clean-stemmed hybrids are best for lumber and plywood, while the branchy types are useful for pulpwood and soil conservation plantings. To give visual evidence of hybrid vigor induced through breeding, a 20-foot tree representing 2½ years growth was included in the group. Further work in selection has yet to be carried on before these poplars are available for distribution.

For this exhibit the Arboretum was honored by the award of a silver medal by the Flower Show Judging Committee, and by mid-week was also the proud possessor of the Bulkley Medal of the Garden Club of America, presented in recognition of "outstanding educational quality and the clear presentation of a most important phase of horticulture and forestry". These were



Fig. 3. The Arboretum Exhibit at the Philadelphia Flower Show.

gratifying rewards for the many hours of work which such an exhibit inevitably represents.

* * *

It might be of interest to take a peep behind the scenes at the January-March preparation for this exhibit, reviewing the methods used to force the plants for this two months early Spring. With questions of layout and plant materials generally decided upon, there is always the problem of how soon to dig the plants and bring them inside—and into what temperature. That was the first teaser to start a series of headaches until the show opened. "Will these be in flower in time? That one is too early—try it in the Springhouse" (cool, the real Pennsylvania kind)—and so on. As the date of the Show drew nearer it became almost a game of putting on more heat and moving plants from one house to another. But to be only a week from "Der Tag" with nothing showing color except a few odd flowers which happened to be practically resting upon the hot water pipes, called for drastic action. From the above observation it was evident that heat was the answer to the problem and heat alone, so the rhododendrons were moved into the propagating house where temperatures could be brought to above 90 degrees F. The buds were also syringed with hot water every half hour, but this was time-consuming. Fertile minds came to the rescue with the ingenious idea of rigging up a lawn sprinkler in the middle of the house, the hose being attached to the hot water outlet, giving the plants a fine hot mist. Under this treatmen the buds soon showed signs of rapid swelling, but even this was not enough to open them in time. An infra-red lamp was tried but it burnt itself out, and a search commenced forthwith for all the electric heaters and for all the extension cords available. After minor repairs these were put into commission and radiant heat was directed onto the buds by having an arc of plants facing these heaters. Unfortunately the damp atmosphere was too much for some of the extension cords (or was it old age?) for there was an excessive quota of shorts. But the goal was in sight for almost miraculously, after all these trials and tribulations, with one day to spare and with few exceptions, the plants were in perfect condition for the show. Well, we suspected it would turn out that way, but if there is to be a "next year" we are going to find something (we hope) that doesn't require forcing!

C. Gordon Tyrrell

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# A Report On Some of the Newer Azaleas

Periodic reports on the behavior of some of the newer plants at the Arboretum are made for the guidance of those who may be considering the addition of such plants to their collections. The present note deals with azaleas—the Vuykiana hybrids and one or two others.

*Azalea Vuykiana:* The Vuykiana hybrid azaleas (exhibited by the Morris Arboretum at the Philadelphia Flower Show this year) are a race of comparatively large-flowered Japanese azaleas produced at the Vuyk Van Nes Nurseries of Boskoop, Holland. They were first imported into the United States in 1927 by Vuyk Van Nes Nurseries of New York City. At the time of importation some varieties had no names and three of them were named by Mr. Adrian Vuyk in this country. As a matter of interest, some of these first plants were acquired by Dr. J. Horace MacFarland who spoke highly of them at Breeze Hill. When importations were resumed in 1946 it was discovered (according to Mr. Adrian Vuyk) that the rest of these azaleas had subsequently been named in Holland and that in consequence the white variety, 'Wilhelmina Vuyk' had received the later name of 'Palestrina', and that 'Helena Vuyk' had also been named 'P. W. Hardijzer'. Vuyk Van Nes Nurseries have agreed not to use these later names, ('Palestrina' and P. W. Hardijzer') and it is to be hoped that they will be discarded by other nurseries in both Holland and the United States now listing these azaleas.

Plants of the varieties 'Beethoven', 'Gerardina Vuyk', 'Helena Vuyk' 'Joseph Haydn', 'Mozart', 'Sibelius', and Wilhelmina Vuyk', were presented to the Arboretum by Vuyk Van Nes Nurseries in November, 1946, and were planted on a north slope with sun exposure about three P.M. The additional varieties: 'Johann Sebastian Bach', 'Johann Strauss' and 'Schubert' have not been tested and are evidently being generally discontinued because of less desirable characteristics.

*Parentage:* Parentage of the Vuykiana hybrids has been variously described as "R. Kaempferi x Ghent Azaleas", "Kurume Azaleas x Azalea Mollis" and "Azalea malvatica hybrids x Azalea mollis"—all of which rather imply sizeable flowers and at least some measure of the habits and toughness of *R. Kaempferi* and the Ghent-Mollis

## TABLE I

### FLOWER NOTES ON THE AZALEAS OF THIS REPORT

| Name | Flower Diameter in Inches | Color—R.H.S. Color Chart |
|---|---|---|
| *R. obtusum Hinodigiri* (For comparison) | 1½ | China Rose—024 |
| *R. obtusum* 'Red Progress' | 1¾ | Rose Madder—23/1 with faint blotch |
| *R. vuykiana* 'Beethoven' | 2¾ | Orchid Purple—31/1 with deeper blotch |
| *R. vuykiana* 'Gerardina Vuyk' | 2 | Tyrian Rose—24/2 with deeper blotch |
| *R. vuykiana* 'Helena Vuyk' | 2½ | Fuchsia Pink—627/1 with deeper blotch |
| *R. vuykiana* 'Joseph Haydn' | 2¾ | Rose Purple—533 with brownish blotch |
| *R. vuykiana* 'Mozart' | 2½ | Fuchsia Pink—627/2 with faint brownish blotch |
| *R. vuykiana* 'Sibelius' | 2 | Jasper—018/1 with chocolate purple blotch |
| *R. vuykiana* 'Wilhelmina Vuyk' | 2¼ | Pure White with yellow-green blotch |

Azaleas. As is indicated in Table I flower size is variable but comparable in general to that of Kaempferi hybrids. Unfortunately neither hardiness nor recognizable botanical characters suggests any influence of *Azalea mollis*. *R. kaempferi* can be detected, and especially in 'Joseph Haydn', there are resemblances to *R. mucronatum*. Furthermore, hybridization tests show ready crossability with the two latter species, but none with *Azalea japonica* or the Ghent hybrids.

*Hardiness:* The past three winters have not been unduly severe, but killing fall frosts have fallen rather early. Under these conditions and with morning sun exposure, October flower bud losses have occurred to some extent with all varieties. In the autumn of 1948 such losses reached 100% with 'Beethoven', 'Mozart', 'Sibelius' and 'Helena Vuyk',* though considerably less with 'Gerardina Vuyk', 'Wilhelmina Vuyk' and 'Joseph Haydn'. Such losses were greater here than occurred in other locations nearby or than in 1947 or 1949. In spite of these findings it is felt that most of the varieties can be planted with good prospect of success in the Philadelphia-New York area and South. North of this range their hardiness will be very questionable.

*Landscape Value:* Flower size and color descriptions for the various hybrids are indicated in the Table. In general the colors are pleasing although the extremes—'Beethoven', an orchid purple (fine large and frilled flower), and 'Sibelius', a brick red,—will need some separation in the garden from the stronger pinks such as 'Helena Vuyk' and 'Mozart'. Their habit is good. It is generally fairly open, and in semi-shade probably comparable to the Kaempferi hybrids. Flowering time coincides with the mid-season Kurumes, 'Helena Vuyk' being about the latest. Perhaps the outstanding one of the entire group is 'Wilhelmina Vuyk' (Palestrina) which carries reasonably large pure white flowers with a pale yellow-green blotch. This is a fine azalea with good foliage and fortunately one of the hardiest of all of them. 'Sibelius' appears to be the most flower-bud tender. As a group, the Vuykiana hybrids are good ornamentals and recommended for addition to the planting list within the area mentioned above.

*Azalea 'Red Progress':* This is a comparatively new hybrid originated by R. DeWilde Jr. and introduced by DeWilde Rhodo-Lake Nurseries in 1947. It is a seedling of *R. sanderi* x *R. obtusum* 'Hinomayo' resembling *R. obtusum* 'Hinodigiri' in many respects including flowering time, though it is a marked improvement over 'Hinodigiri' in color. As is indicated in the Table, whereas the latter is a strong and rather tiring red, 'Red Progress' is somewhat lighter and much softer in color. Its flowers are slightly larger than those of 'Hinodigiri'. Comparative hardiness of the two seems very similar so that it can be classified among the hardier Kurumes.

*Azalea 'Pink Progress':* A second variety by the same originator is *Azalea* 'Pink Progress' of the same parentage as the foregoing. It is an azalea of the same general type and habit with good clear pink flowers of larger size than 'Hinomayo', and opens a few days later than 'Red Progress' or 'Hinodigiri'. An RHS Color Chart description was not obtainable for inclusion in the Table.

Both these varieties have suffered some fall flower-bud loss in the rather exposed situation in which they have been growing. But 'Hinodigiri' has also, so that for the same locations in which 'Hinodigiri' is reasonably satisfactory, Azaleas 'Red' and 'Pink Progress' are recommended for both color and performance. H.T.S.

*Not 'Wilhelmina Vuyk' as was erroneously reported in the *American Rhododendron Yearbook*, Table I, 1949.

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FIG. 4. LORENZO LORRAINE LANGSTROTH

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.




Fig. 5. Langstroth Memorial Bench, unveiled October 20, 1951

## INSCRIPTION

In bee hives of a century ago, bees fastened comb to the hive walls. Removal was possible only by cutting, often after killing the bees. Management of colonies under this crude procedure was difficult, and apiculture languished.

In 1851 Langstroth discovered a new basic fact of bee behavior: They respect and leave open any hive spaces 3/8 inch wide, whereas they seal narrower ones with bee glue and utilize wider ones for comb.

Brilliantly applying this fact, Langstroth designed the moveable-frame hive, the frames separated from each other and from the hive walls by the inviolate "bee space." With its comb-containing frames now freely moveable without injury to bees or comb, the Langstroth hive ushered in a new era in bee culture.

Important to man as is the honey garnered by bees, it is vastly surpassed in value by their role as pollenizers of plants of the orchard, field, forest, and garden. Thus the great development of apiculture made possible by Langstroth's work confers incalculable benefits on a much wider front in our economy.

It is fitting, therefore, that this bee garden of trees and shrubs be gratefully dedicated to his memory in the community where he was born and reared; and in which a century ago he made the basic discoveries which revolutionized beekeeping throughout the civilized world.

# THE LANGSTROTH BEE GARDEN

## FOREWORD

High on the list of educational developments at the Morris Arboretum had long been a garden or collection of trees and shrubs significant in apiculture. And it seemed eminently appropriate that such a garden be named in honor of Lorenzo Lorraine Langstroth (1810-1895), a Philadelphian who through his studies probably contributed more than anyone before or since to the development of successful bee culture in America.

Since 1951 marked the centenary of his greatest discovery, it was decided to initiate the garden and to dedicate it within that year, even though the collection obviously would be in its infancy. And when it is recalled that Langstroth attended the University of Pennsylvania Preparatory School and years later did his epoch-making work in his apiary in West Philadelphia on ground now University campus, there is added appropriateness in honoring his memory in Philadelphia and under University auspices.

Taking advantage of an already existing group of trees and shrubs germane in large part to a bee garden, the Langstroth Memorial was established on an area upwards of an acre in that portion of the Morris Arboretum situated in Montgomery County and known as "Bloomfield." Plantings in the spring of 1951 brought the total number of native and exotic species and varieties of woody bee plants in the garden to about seventy. Additions will be made as plants and authentic information become available.

From time immemorial man has treasured and nurtured honey bees for the honey they produce. And honey, delectable product that it is, will always retain its compelling appeal, even though as the chief source of sugar for man it has long been overshadowed by such prolific sugar crops as sugar beets and sugar cane. But in recent times, especially under the rapid change in agricultural practices during the past half century, honey bees have attained a vast importance in our economy in quite another direction, namely, as pollinators of important crop plants. Indeed, so great now is their role in this connection that, viewing the beekeeping industry as a whole, honey production is becoming of secondary importance.

This subject is treated at length by Dr. James I. Hambleton in his paper delivered at the dedication and printed in pages that follow. Brief reference is made to it here, however, to call attention to the vital interrelations between bees and plants and therefore the appropriateness of a "Bee Garden" in an Arboretum with research and educational objectives. As time goes on these basic interrelations are to be increasingly illustrated by appropriate plants accompanied by suitable explanatory material to make these interrelations intelligible to the public. It is hoped, too, that the garden may stimulate research in the vast and important field of the interdependence of plants and their pollinators —a subject largely unexplored and in which the honey bee is steadily assuming greater and greater significance.

Though it will require considerable time to develop the full potentialities of the garden, the Morris Arboretum is happy that the undertaking is launched, and that this was consummated in the centennial year of Langstroth's greatest discoveries. The Arboretum is further appreciative that it has been privileged to sponsor what is apparently the first tangible recognition in Philadelphia of one who was himself a Philadelphian and whose great work on honey bees laid the scientific and practical foundation of modern bee culture.

This brief foreword cannot close without expressing appreciation to the many whose generous help contributed so largely to the initiation and successful launching of the Langstroth Bee Garden. Our thanks go first of all to the speakers at the dedication exercises. Of the others, above all members of the bee fraternity, space precludes mentioning them all. But special acknowledgment must be made to the members of an informal group for their effective contribution, especially during the formative period of the enterprise, namely: Professor W. W. Clark, Extension Apiarist, Pennsylvania State College; Mr. Charles K. Hallowell, Philadelphia County Agricultural Agent; Mr. Harry Pye and Mr. Edward R. Glenn, prominent members of local beekeepers' associations; Mr. Paul Cummins, President of the Montgomery County Beekeepers' Association; and Mr. Elmer Reustle, Past President of the Pennsylvania State Beekeepers' Association. The last also generously underwrote in large part the fabrication of the Langstroth Memorial Bench.

To the final member of this group, Mr. Fred W. Schwoebel, well known Philadelphia beekeeper and student of hive life, particular acknowledgment is due. It is to him that the

Arboretum is indebted for the suggestion that the Bee Garden might appropriately be constituted a memorial to Lorenzo Lorraine Langstroth, at the same time calling attention to 1951 as the centennial year of Langstroth's most memorable discoveries. It is indeed fortunate for the Arboretum that Mr. Schwoebel, who for some years has maintained stands of bees in the Arboretum, has consented to act as Curator of the newly established garden. His deep interest in bees, in Langstroth, and in the garden augur well for the future of the enterprise.

Special thanks are due, too, to the liberal contributors to the impressive exhibit staged in the Morris Mansion on the dedication day: Mr. Paul Holcombe, State Bee Inspector of New Jersey; Mr. William Reed, of Philadelphia; Professor George J. Abrams, Professor of Apiculture, University of Maryland; Professor Edwin G. Anderson, Professor of Apiculture, Pennsylvania State College; Mr. Paul Cummins; The Pennsylvania Horticultural Society, and Mrs. Marion Code, Librarian of the Society; The Academy of Natural Sciences, and Dr. Venia T. Phillips, Librarian of the Academy. To Mr. J. Worthen Vrooman the Arboretum is also indebted for providing the excellent address system used at the outdoor dedication.

Unique in the exhibit were the Langstrothiana kindly brought by Mr. William Langstroth Cowan, grandson of our hero, from his home in Toronto, Canada. Among these were such precious documents as the original United States patent papers granted to L. L. Langstroth on his moveable frame hive, those referred to in Mr. Cowan's Reminiscences, and many others.

Finally it must be recorded that, largely through the lively interest of Mr. W. L. Cowan, and also of Mrs. Cowan, the Arboretum and the dedication occasion were signally honored by the presence of five direct descendants of L. L. Langstroth: Mr. William Langstroth Cowan, grandson, from Toronto, Canada; Mr. A. H. Cowan, grandson, from Erie, Pennsylvania; Miss Anna L. Cowan, granddaughter, from Dayton, Ohio; Mrs. Peggy Cowan Kohler, great-granddaughter; and Mr. George Cowan, great-grandson, from Pittsburgh, Pennsylvania.

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# PAPERS READ AT THE DEDICATION

## LANGSTROTH AND THE ACADEMY OF NATURAL SCIENCES

M. Albert Linton

*President, Academy of Natural Sciences of Philadelphia*

When one knows absolutely nothing about a subject, an effective way to remedy the situation is to agree to make a speech about it. That was exactly my condition a few months ago when I was asked to represent the Academy of Natural Sciences on this occasion. I could not recall ever having heard of the Rev. Lorenzo Lorraine Langstroth before Mr. Schwoebel's article in a recent issue of *Frontiers;* and what I knew about the development of honey bee culture was practically nil. However, I am glad to say that I have advanced a wee bit beyond that abysmal stage. Moreover, the process of so doing has been a pleasant one. Mr. Langstroth has proved to be a most interesting character, and his book on the honey bee a fascinating one.

I am reminded of the botany professor who was prevailed upon by a colleague, a professor of anatomy, to take the anatomy class for a few weeks while the anatomy professor went on a scientific expedition. Shortly afterward a friend asked the substitute professor how he was coming along as a teacher of anatomy. "Oh" he replied "by burning the midnight oil and studying furiously, I am able to keep about one bone ahead of the class." Maybe the information I have recently acquired about Langstroth and his bees puts me in that position relative to some of you here gathered today.

My subject is Langstroth and the Academy of Natural Sciences of Philadelphia. Langstroth, born in Philadelphia on Christmas day, 1810, left the city of his birth at the age of seventeen to enroll at Yale University; and after his graduation with Phi Beta Kappa distinction, he entered the Yale Divinity School. Going from there to a pastorate in Andover, Massachusetts, and later removing to Greenfield, Massachusetts,



Fig. 6. Part of audience at dedication exercises listening to the reminiscences (see later pages) of Mr. Wm. Langstroth Cowan on his grandfather Lorenzo Lorraine Langstroth.

he did not again take up his residence in Philadelphia until 1848. In 1852 he left Philadelphia, never again to reside in the city of his nativity.

It is during this period of four or five years that his contacts with the Academy developed. And these were precisely the years of his most intense and productive work on honey bees and hive life, work which has benefited so profoundly and on a world wide scale a branch of husbandry the full importance of which is still not fully appreciated.

Before pursuing further Langstroth's relations and contacts with the Academy I should like to recall something that happened in his sophomore year at Yale which throws light on his independence of mind and character.

Food in the common dining room became so inferior that the students staged a "Bread and Butter Rebellion." Crowds gathered about the dining hall but no one entered—a stand-up noncooperative strike. Despite promises by the faculty to remedy conditions, the students refused to enter the dining hall until the promises had been made good. Langstroth, recalling his promise to his parents to obey college laws, announced his intention of entering the hall whatever his comrades might do. A committee was appointed to remonstrate with him—all to no avail. At the time of the third boycotted meal he boldly entered the hall alone accompanied by yells of execration and some throwing of stones. The faculty, fearing for his safety, voted to excuse him from entering the hall again. Not to be brow-beaten by his fellow students, he entered for the next meal, this time accompanied by several others, most of whom were professors of religion. His courageous course of action, at first so unpopular, in the end made him a host of friends.

When Langstroth lived in Philadelphia the Academy was located at the northwest corner of Broad and Sansom Streets, just two and one-half blocks from Langstroth's home at what is now Chestnut and Sixteenth Streets. The record shows that he was elected to membership on September 30, 1851, one hundred years and twenty days ago. Between the time of his election and final departure from Philadelphia the next year, the minutes record him as present at nine meetings of the Academy.

A search has revealed only two occasions on which he published in the Proceedings of the Academy. The more important of these, and of the greatest interest on this occasion, was his paper entitled "The Impregnation of the Eggs of the Queen Bee," appearing in the 1852 volume (Volume 6). In this study he had the help of Dr. Joseph Leidy, who in turn had the assistance of Dr. Charles M. Wetherill, another Academy member and a chemist. Leidy was then a

young man who later became the distinguished President of the Academy from 1882 to 1891 and one of the foremost of American biologists. Many of you are doubtless familiar with the fine bronze statue of Dr. Leidy which formerly was on City Hall Square but now happily and appropriately located in front of the Academy on Race Street near Nineteenth.

Leidy carried out the microscopic observations involved in Langstroth's study of the queen bee, help of which Langstroth was profoundly appreciative. Thus he states in his famous book, "On the Hive and the Honey Bee"—"No man in this country or Europe was more competent to make the investigations I desired." This paper on the queen bee, read before the Academy February 4, 1852, for the first time—without a question of doubt — established the true function of the queen bee and the drones in the hive. It is therefore an important contribution and one peculiarly intimately associated with the Academy. The manuscript of this paper in Langstroth's own hand, normally in the Library of the Academy, is on display in the exhibit arranged by the Morris Arboretum for this occasion in the Morris Mansion across the way.

The only other publication in the Proceedings of the Academy is a note entitled "On the Honey Ants," which also appeared in the Volume for 1852. Langstroth presented it before the Academy on May 11, 1852, Dr. Leidy adding some remarks on the subject. The study was undertaken as a result of receiving from Langstroth's brother a shipment of honey ants from Mexico.

Academy records also reveal that on one occasion Langstroth presented to the Academy some royal cells of the honey bee and made some observations on them which are recorded in the Proceedings.

We shall doubtless hear in what is to follow on this program about our hero's fundamental discovery of the "bee space" in 1851, just at the time of his active membership in the Academy. That he did not also publish in its Proceedings this epoch-making work on the "bee corridor" and its brilliant application to hive design, is doubtless due to the fact that he incorporated them in his famous book "The Hive and the Honey Bee," the first edition of which, a volume of 384 pages, appeared in 1853. Langstroth presented a copy to the Academy, which likewise is on display in the current exhibit already alluded to. Although not autographed, it is annotated on the flyleaf in his own hand "Presented by the Author on the usual conditions, 22d July, 1853." This book went through three editions, many printings, and was translated into five European languages, achieving world-wide acclaim.

We shall doubtless hear more about this classic from those who will follow me in this program. But here I should like to remark that even one altogether unfamiliar with bee culture can get a thrill from this book. Its style is friendly, easy to read, adorned with appropriate classical references, and above all fascinating in the story it has to tell. Langstroth was a master in narrative and exposition. A vast amount of valuable information and advice about hives and beekeeping is included in the book. No wonder that it had such a world-wide decisive influence upon honey bee culture. If any of you here today are not familiar with it, I assure you it will repay your browsing through it.

As already indicated, the active connection of Langstroth was limited to some four or five years. Had he remained in Philadelphia this relation, keen and penetrating naturalist that he was, would surely have been long continued. But brief though it was it was fertile and productive.

Though the membership of the Academy at the time was only some 170, it was a very active period in the Academy's long history in which a goodly company of men of distinction took part. We need recall only a few of the noted figures active in the intellectual and scientific life of the Academy at the time: The loveable and illustrious Dr. Leidy already mentioned, distinguished zoologist, paleontologist and anatomist; Thomas Nuttall, the famous botanist and student of American flora and avifauna; Samuel George Morton, the anthropologist and later President of the Academy; Walter Johnson, outstanding mineralogist; Charles Pickering, botanist on the Wilkes Expedition; Isac Lea, noted conchologist; S. S. Haldeman, entomologist; John Cassin, Corresponding Secretary of the Academy at the time of Langstroth's election and a noted ornithologist. In the company of such kindred illustrious spirits, we may be sure that Mr. Langstroth was happy and at home.

# THE NEW ROLE OF HONEY BEES IN AMERICAN AGRICULTURE

Jas. I. Hambleton

*In Charge of Bee Culture, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture*

It is a great pleasure, as well as an honor, for me to be invited to take part in this memorable occasion—the dedication of the Langstroth Bee Garden. The mere fact that a great institution, such as the University of Pennsylvania, is thus recognizing the achievements of Reverend Langstroth, a humble beekeeper, is significant in itself. This occasion reminds me of a somewhat parallel case a number of years ago, when the Ohio State University granted an Honorary Doctor's Degree to Mr. E. R. Root of Medina, Ohio. Throughout the years of its existence, Ohio State University has granted hardly more than fifty honorary degrees. One would judge from this that candidates to receive this honor are selected with great care. My regard for the University, which was already high, rose further when I considered that in honoring Mr. Root, a figure well known in the beekeeping world, it also recognized the importance of honey bees in everyday life—a fact which Mr. Root did much to promote.

When I was asked to appear on this program, I accepted with some reluctance. I was well aware that there would be speakers present who were much better qualified than I to speak about the life and work of the man whose memory is being honored today. I, therefore, decided that I had better confine my remarks largely to the bees themselves. In the preface of his book "The Hive and the Honey-Bee," Langstroth quotes a poem from Bowring to express his own regard for the bee:

"What well-appointed commonwealths! where each
Adds to the stock of happiness for all;
Wisdom's own forums! whose professors teach
Eloquent lessons in their vaulted hall!
Galleries of art! and schools of industry!
Stores of rich fragrance! Orchestra of song!
What marvelous seats of hidden alchemy!
How oft, when wandering far and erring long,
Man might learn truth and virtue from the BEE!

It is true, of course, that honey bees are the same today as when Langstroth was in his prime. But I believe it is correct to state that the honey bee occupies a somewhat different role in American agriculture, and thus in the lives of all of us, than it did during Langstroth's time. Reverend Langstroth, as a beekeeper, was interested in exploiting these insects in such a way as to return the maximum of pleasure and profit to those who kept them. His invention of the movable-frame hive, in 1851, marked the beginning of an era when man for the first time could really take advantage of the behavior and industry of these insects to benefit himself. Commercial beekeeping came into existence, and the hive we use today is in principle the same as that invented by Langstroth.

On reading the works of Langstroth one finds few references to the part that bees play in pollination. It is to this phase of the honey bee, however, that I should like to extend my remarks.

For many years biologists have been aware that certain insects, particularly those that feed on nectar and pollen in both the mature and immature stages, are essential agents in transferring pollen from blossom to blossom on the same plant or from the blossom of one plant to that of another of the same species. Without these agents, usually bees of one kind or another, pollination does not take place and the plant remains barren of fruit or seed.

For the sake of illustration, we might roughly divide the flowering plants into two groups: (1) those that bear blossoms with light dry pollen, permitting pollination through the instrumentality of wind and gravity; (2) those that bear heavy sticky pollen which is not blown by the wind. The first group contains many important and well known plants, such as cereals (wheat, corn, oats, rye, barley), most other grasses, many forest trees, a few cultivated fruits, and many wild or non-cultivated plants. In the second group, which requires insects (occasionally other animals) to transfer pollen from anthers to stigmas or to expose reproductive parts before pollination can take place, will be found many of our cultivated crops.

Almost all varieties of apples must be pollinated with pollen from a different variety of apple. If a hive of bees is placed under the netting covering an apple tree in full bloom, no matter how well the bees work the blossoms, little or no fruit is formed because the apple requires cross-pollination with another variety. All varieties of sweet cherries require cross-pollination with another variety. Plums, pears and some varieties of peaches also fall into this category. It is characteristic of the cucurbit family, to which belong the pumpkin, squash, watermelon, cantaloupe, and cucumber, that the male and female elements are borne in seperate flowers on the same vine. Here, again, is an example



Fig. 7. Young Sourwood or Sorrel-Tree *(Oxydendrum arboreum)* in the Langstroth Bee Garden. An important bee plant of southeastern United States yielding a superb honey.

of a plant bearing a heavy, sticky pollen which the wind cannot transfer from the male to the female flower. Insects must do the work. Occasional cantaloupe flowers are hermaphroditic (stamens and pistil in the same flower). In such flowers, pollen transferred to the stigma of the same flower usually will not result in fertilization; cross-pollination is required. Almonds require insect pollination and many of the legumes are entirely dependent on bees for seed production. In the case of the alfalfa flower, unless tripped by an insect the reproductive organs are never exposed to view and therefore remain inaccessible for pollination. As a result the flower eventually withers and falls from the plant without forming seed. An insect must first trip the blossom to expose the stamens and stigma; and, that not being enough, must transfer pollen from another flower (cross-pollination) if seed is to result. The red clover blossom also requires tripping and the transfer of pollen from another blossom before the ovary can develop its quota of seeds. The production of cabbage seed depends on bees; similarly radish, kale, cauliflower and most of the other members of the cabbage family. Bees are necessary for the production of onion and carrot seed as well.

I have made no attempt to give a full list of plants that are completely dependent on bees for fruit and seed production, or plants that produce better when pollinating insects are plentiful. However, some fifty of our cultivated crops fall into this class. In addition, there are many wild plants, forest trees, etc., that are benefited by insect pollination. This is sufficient, however, to emphasize that many of our most delectable food sources would be denied us if it were not for pollinating insects.

At this point I should like to refer for a moment to an earlier time in the history of this country. When the Pilgrims landed in this virgin country there was certainly no pollination problem as such. For centuries there must have been maintained a balance between plants that required insect pollination and the numbers and availability of the insects that were capable of effecting pollination. The reproduction and natural succession of plants was little disturbed by man. However, when our forefathers began to hew down the forests in order to cultivate the ground for the growing of food for their tables, there was started a nature-upsetting process that has continued to the present day. When a large tract of land is planted to a given crop, several things happen. For one thing, the ground is disturbed and, as most pollen- and nectar-consuming insects—mainly bumble bees and solitary bees of one kind or another—nest in or close to the ground, their nesting sites are destroyed. A wide variety of plants no doubt flourished on the land in its native state, plants that provided continuous bloom from early in the spring until frost. But when that land is planted to alfalfa, let us say, the succession of blooming flowers is destroyed. It is only during the few weeks alfalfa is in blossom that it provides a livelihood for bees. At this time there are such a vast number of blossoms that the insects present are too few to go around, if a seed crop is to result.

The United States is, or was, blessed with many species of pollinating insects. Bumble bees are well known to everyone. Of all the native pollinators, the bumble bee is the only social insect. Honey bees, of course, are social insects of the highest order but are not native to America. The others, such as *Megachile* and *Nomia,* are solitary. The female makes a nest in a burrow in the soil, or in the hollow stem of a plant, provides it with pollen, lays her eggs, and the young emerge without further care by the adult insect. Plowing and cultivation of the soil destroy these insects. Major changes, such as drainage of swamp lands, irrigation of arid lands, cutting out woodlands, clean cultivation, elimination of weeds, all combine to destroy the beneficial insects. The native or wild pollinating insects have gone, or are going, the same way as the Indian. The insects, however, are more unintentional victims of the white man than were the Indians.

Of recent years, a still greater threat has affected the welfare of the beneficial insects,

namely, the employment of chemicals to destroy the insect pests that attack our cultivated crops. Up to the time of World War I, insecticides were almost unknown. The discovery that the arsenicals were effective in controlling the codling moth, potato beetle and other insects attacking our crops in wholesale numbers, resulted in the usage of vast quantities of these materials. For many years following World War I, the arsenicals in one form or another largely were depended upon to safeguard our crops from insect ravages. During World War II, however, DDT was discovered and it was found almost at once that this chemical was highly effective in freeing our troops of body lice, fleas and other vermin. Entomologists soon found that the same chemical could be used effectively in controlling a large variety of insects and that house flies, in particular, succumbed magically to this insecticide. Whole communities were freed almost overnight from this pest. Mosquitoes were also miraculously eliminated when DDT was dusted over their breeding places. Following the discovery of DDT, other new insecticides came into being—benzene hexachloride, chlordane, parathion, and many others.

These new organic chemicals can be looked upon as the miracle insecticides of this era. Small quantities were highly efficacious, so much so that formulas and methods of application have been developed to the point where, for the first time, it has become economical to treat crops that have never been protected by insecticides. Application by airplane has made it feasible to treat fields of standing corn, alfalfa fields, swamp areas and forest lands. As a result, today we find few crops that are not treated at one time or another with insecticides. Man's clothing is destroyed by insects and the very timbers of his house are attacked. His food, in all forms, from the growing stage to the packaged form, is subject to insect attack. His health is affected by mosquitoes, fleas and other insects that either annoy him and his livestock or that act as carriers of such diseases as malaria, yellow fever, bubonic plague, and typhus.

Most insecticides used today are non-specific in respect to their toxicity to any one species of insect. DDT and other organic insecticides are effective against many kinds of insects. When these toxic materials are applied over the length and breadth of the country, not only do the injurious insects fall prey to their usage but many of the beneficial ones as well. In man's effort to keep the upper hand he is taking two steps forward and one step backward. If beneficial insects were limited to bees, the flower visitors, losses could be minimized by not spraying during the blossom period. However, parasitic and predacious insects are beneficial in that, when given a chance, they will destroy harmful insects. We are thus systematically destroying the very insects that can help us keep the injurious insects under control. Pollinating insects have been destroyed in such numbers that the effect is readily seen in lowered seed and fruit production—today during a period we like to consider the most progressive era in American agriculture.

In addition to the unwitting destruction of the beneficial insects, another element is creeping into the picture which demands the immediate consideration of all officials having to do with the welfare of mankind. After several years usage, it was discovered that house flies were developing resistance to DDT. Resistant strains of this insect have developed in a remarkably short time, to the point where DDT can no longer be used to control them effectively. Also, it was discovered that once an insect developed strains resistant to DDT, it quickly developed races resistant to some of the other organic insecticides as well. Today we are faced with the fact that already we cannot depend upon DDT to control house flies. Body lice on our troops in Korea cannot now be controlled with DDT. Mosquitoes have developed strains resistant to this insecticide and cockroaches are falling into the same category. Certain species of mites have developed races resistant even to parathion, one of the most toxic of all insecticides. The question is, therefore, what are we going to do? Are we going to be compelled to develop still more toxic insecticides to keep the upper hand on injurious insects? Are we rapidly approaching the time when we shall not be able to live without a daily dusting with some insecticide?

The Japanese beetle is not a pest of agriculture in its homeland, Japan. Consider the tremendous damage that this imported pest has done in this country. Our attack on this insect has been largely through means of chemical control; nevertheless, it has steadily spread throughout the Northeastern States. Has not the time come when we must try to restore the balance between the injurious and the beneficial insect? Should we not at least attempt to pit one against the other in order to free ourselves of complete slavery to insecticides? Once biological control is established, there is little more to be done. It is the most economical method of control in the long run and by far the safest. There is no poison-residue problem. Most of the insecticides used today are not only destructive to insects, but can be harmful to man and livestock as well.

I mention all this because honey bees are also subject to destruction by insecticides. In certain sections of the country beekeepers have had to abandon keeping bees because of poisoning hazards. We know so little about the biology

and habits of the native pollinating insects that nothing today is being done to conserve them, let alone to propagate their numbers. The result is that we must rely on the honey bee, which man can protect to a certain degree against insecticides, if we are to continue raising legumes for soil improvement and feed for livestock, and to continue to enjoy fruits and many other delectable foods.

In 1925 Utah produced a top crop of 26 million pounds of alfalfa seed. From that high point, the production per acre, as well as total production, has steadily declined until today it hovers around 3 million pounds. Every effort has been made to stop this downward trend. In trying to learn why this decline has occurred, little thought has been given to the part that bees play in seed production. The average production of red clover seed per acre in the United States is about 9/10 of a bushel. Yet red clover thrives and blossoms as well as it ever did. An ordinary good stand of red clover today produces enough blossoms, weather conditions being satisfactory, to produce 8 or more bushels of seed per acre. Pollinating insects, however, must be present in sufficient numbers to effect the enormous job of cross-pollination. An care of alfalfa or red clover may contain upwards of 500 million florets per acre. Why should we expect nature to provide the pollinating insects? In other words, we have already reached the point where pollination as a crop requirement must be planned and provided for in the same way as other recognized crop practices, such as soil fertility, drainage, moisture, good seed, etc.

In 1946 the U. S. Department of Agriculture established the first experimental plots to determine just what role bees played in alfalfa seed production. After a few years of patient work and close observation, it became apparent to those working on the project that at least two things were necessary to turn the trend in seed production, namely, that injurious insects must be controlled and that pollinating insects must be provided to produce a profitable crop. In one experiment conducted in California, a field of 132 acres of run-down alfalfa was used to demonstrate what honey bees could do. Hives of bees were placed on the perimeter of the field; also, rows of hives were scattered throughout the field, even though some alfalfa had to be trampled down in order to place the hives. Slightly over 5 colonies per acre were used on this plot. The result was a harvest of 1120 pounds of thresher-run seed per acre. The State average was 275 pounds of clean seed.

When colonies of honey bees are placed in such concentrated numbers, there are not enough flowers for the bees to produce a crop of honey. The use of bees in this manner is, therefore, non-productive to the honey producer. If his bees are used for pollination, he must be paid for this service in the form of cash or in a certain percentage of the seed harvested. As a result of this work, California has caught on rapidly to the idea that bees must be brought into alfalfa fields if profitable crops of seed are to be produced. The upward turn is very much in evidence. Recently an agronomy authority in the State prophesied that, with the excellent soil and weather conditions prevalent and with a continued and planned use of bees, California alone could provide the nation with all the alfalfa seed required. As a result of the experimental work, records of all kinds are being made in high seed production from alfalfa, ladino clover, sweet clover, and red clover, where bees are used as a cultural practice in the production of the crop.



Fig. 8. A glimpse in the Bee Garden, with the Langstroth Memorial Bench. The very durable wood of the "Shipmast" variety of Black Locust *(Robinia pseudoacacia* var. *rectissima)* was used throughout in constructing the bench. Black Locust yields an excellent honey.

More recently, experiments were conducted in Arizona which proved the value of honey bees in fields of cantaloupe. Where honey bees were excluded from the melon vines, practically no fruits were produced. Where bees were provided in plentiful numbers, 61 more crates of melons per acre were produced than were obtained elsewhere in the field where nature alone provided the pollinating insects. It was found further that when pollinating insects were plentiful, more crown fruits (those closest to the root and the best fruits) were developed in contrast to the poorest fruits produced farther out on the vine; and that these fruits were larger, contained more sugar and more seed. This past year, as a result of this one experiment, there were very few cantaloupe fields in Arizona that did not have a line of bee hives to provide pollination.

Little or no attention has been given to the part that bees might possibly play in the pro-

duction of cotton. The cotton plant is abundantly provided with nectaries. Some of these are on the leaves, and some are at the base of the flowers. A few investigators have ventured to say that bees might possibly play an important part in the production of cotton seed and lint. But, as in many other plants, the role of pollinating insects has not been determined. The cotton blossom is largely self fertile, yet in some species the stigmatic surface is not always well covered with pollen. It is quite possible that these beneficial insects can be utilized to benefit this crop, which on the surface would seem to be aloof from service by pollinating insects.

I have brought you on a long and seemingly roundabout journey. All of us are gathered here to commemorate the memory of a man who made possible modern beekeeping. We shall appreciate more and more our indebtedness to him as the world slowly recognizes the role which honey bees play in the life of every one of us. The dedication of this Memorial Garden will remain as a living and growing monument to the work of this great man, who devoted so much of his life and effort to promote the study of the honey bee, the insect which provides our only source of honey and beeswax, and is increasingly responsible for the burden of pollinating a vast array of our most delicious and essential foods. I wish to commend the Morris Arboretum of the University of Pennsylvania and the beekeepers and others whose wisdom and foresight made possible the creation of this Memorial Garden.

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## REMARKS INTRODUCING MR. E. F. PHILLIPS, JR.

EDWIN J. ANDERSON

*Professor of Apiculture, Pennsylvania State College*

All of us were profoundly sorrowed as we learned of the death of Dr. E. F. Phillips, Professor Emeritus of Apiculture at Cornell University. It is a grievous loss to our industry.

Those of us who knew Dr. Phillips well experienced a great deal of satisfaction as we observed how one outstanding leader recognized the work of another, as Dr. Phillips recognized the value of the discovery made by Rev. L. L. Langstroth. It was due to Dr. Phillips' keen appreciation of values that the beekeeping industry of today became aware of the significance of the discovery made by Rev. Langstroth. As we review the work of these two men, it is noteworthy that both should have spent unusually fruitful periods of their lives in exactly the same area—that occupied by the University of Pennsylvania.

Dr. Phillips learned about honeybees for the first time when he was a graduate student at the University. The problem suggested to him at that time by his faculty advisor introduced him to the field of beekeeping, and started him on his life's work as we know it today. The subject given him for his doctor's thesis was "A Study of the Compound Eye of the Honeybee." While working with this problem, the then young E. F. Phillips became interested in this valuable insect and saw the need for an extensive research program in beekeeping. Upon leaving the University, he was selected as the one qualified to head the beekeeping work in the United States Department of Agriculture. It is, therefore, the selection of this thesis subject on bees and the training at the University of Pennsylvania to which we indirectly owe much as an industry.

In the later years of his active life, Dr. Phillips spent many long hours tracing the activities of Rev. Langstroth from youth through his last days. Neither time nor expense was spared as he traveled from the region where Rev. Langstroth spent his youth, through each step of his life's activity, in the hope of finding a few more facts from the old residents or the records of each community where Rev. Langstroth had spent some time. I believe that few things in his life gave Dr. Phillips greater satisfaction than the discovery of each new fact about Rev. Langstroth.

It is the accumulation of the results of all this effort that has finally made it possible to tell the story soon to be presented by the son of Dr. E. F. Phillips, Mr. E. F. Phillips, Jr. Unfortunately for our industry, the speaker did not choose to follow in his father's footsteps. We are none the less appreciative, however, of his interest in his father's work and his willingness to present the manuscript which his late father had completed for this occasion before his untimely death on August 21.

# LANGSTROTH—PHILADELPHIA BEE KEEPER

E. F. Phillips

*Late Professor Emeritus of Apiculture, Cornell University*

It is eminently appropriate that the celebration of a discovery made by Lorenzo Lorraine Langstroth should take place in the Philadelphia area, on a date close to that of the actual discovery. Langstroth was a Philadelphian and his name should be perpetuated here more than in any other place.

He was born in 1810 as a Christmas gift to a loving family as well as to an important part of humanity in need of his benefaction. His birthplace was 106 South Front Street, which he described as "not far from Independence Hall."

His grandfather, Thomas Langstroth, had come from West Riding, in the parish of Horton, Ribblesdale, England. Near here the River Wharfe rises in a mountain valley which still bears the name of Langstrothdale. At twenty-two, in 1767, Thomas Langstroth came to America on business, decided to remain in this country, and never returned to his homeland. Here he married Ann Youck, whose parents had come from Prussia and settled in Germantown. They had twelve children, of whom eight lived.

The fourth son, John George Langstroth, Lorenzo's father, married Rebecca Amelia Dunn, the daughter of an English family which had settled on the Eastern Shore of Maryland. Her mother traced her ancestry to the Lorraines, Hugenots of nobility, who had fled from France after the revocation of the Edict of Nantes. Thus our Lorenzo Lorraine Langstroth traced his origins to England, Germany, and France.

He was the second of eight children and the oldest son. As a child he developed an unusual interest in the habits of insects, and he recorded in his reminiscences that he was "whipped" as a young boy for wearing out the knees of his trousers "by too much kneeling on the gravel walks" in his eagerness to "learn all he could about ant life." Langstroth also tells of his observations of the habits of the cicada, which he began watching in Center Square (now City Hall Square) at the tender age of eight, and continued to observe each season of their emergence until he was twelve. Forty years later when he returned to Philadelphia, it was again a locust year, and he collected large numbers of pupae (which he called larvae) from trees in Independence Square. These he showed to his daughter, and she and some of her companions sat up until after midnight with him watching the curious changes as the pupae became adult cicadas. The childhood interest of Lorenzo in insect life is significant as a kind of prophecy of his later keen observations of bee-life.

The neighborhood in which young Langstroth grew up was at that time a choice residential section, but it is now changed beyond recognition. Today it teems with commercial activity.

Langstroth attended the preparatory school conducted by the University of Pennsylvania and studied the usual required subjects of that day, which would probably be regarded as of little practical value by the parents of today's children. The demands for college entrance, then as now, were severe; but in those days they included, besides Latin and a modern foreign language, Greek and a heavy schedule of mathematics. None of the interesting new fields of study which today are required were included, nor even recognized.

At seventeen, Langstroth entered Yale College, where his curriculum may be described as "more of same." Again he studied the classical languages, including Hebrew, more modern languages, advanced mathematics, logic, some history, and abundant rhetoric. The only course in the curriculum which even faintly suggests the biological sciences was one in "Paley's Natural Theology, or Evidence of the Existence and Attributes of Deity." The modern biologist would scarcely consider this an adequate training for work on the behaviour of an insect. Nevertheless, this was Langstroth's preparation for his scientific contribution to beekeeping. In favor of the stiff curriculum, it may be said that anyone who could survive all those courses at least learned to use his mind.

During Langstroth's senior year at Yale, the course of his future life was determined by the arrival of a new student, Peter Parker, who became his good friend. Parker had transferred from Amherst to Yale for the senior year, and it soon became apparent that he was deeply religious and desired to convert his classmates. Langstroth had not up until this time been concerned with religion; but after long discussions with Parker, he was the first man in his class to be stirred by the latter's preaching. Before the year was out, a number of the class had followed Langstroth's example and given up worldly things. The movement was sufficiently profound to be known later in Yale circles as "The Revival of 1831."

Nowhere in his writings does Langstroth indicate whether he had a plan for his future before his interest in religion became so intense; but now he decided to give his life to the Christian ministry. Therefore, after his graduation in 1831 he entered Yale's Theological Seminary, even though he knew that his father would not be able to help him financially because of recent business reverses. In his reminiscences he says, "I felt strongly persuaded that if, with a college course, I had not sufficient energy to finish my theological studies from my own earnings, I gave but poor evidence of having any call to preach the gospel."

To support himself, Langstroth now took up teaching, giving courses in schools for young ladies in New Haven; and for at least one year he held a full-time teaching position in a village across the Hudson from West Point. In his fourth year after graduation, Langstroth was made a tutor in mathematics at Yale, and at the same time came an opportunity to engage in the work to which he had dedicated his life.

During Christmas vacation, he supplied the vacant pulpit of South Church, Andover, Massachusetts. He made such a favorable impression on the congregation of South Church that he was asked to become its pastor on January 7, 1836. The three-year period of his pastorate at Andover in many ways was a happy interlude, although it was attended with certain difficulties. He had become increasingly subject to severe headaches accompanied by indications of melancholia. Also his mother and sister became dependent upon him, just at the time of his marriage to Anna Tucker, a daughter of the head of one of the schools in which he had taught in New Haven.

Langstroth came to know Anna Tucker through their mutual interest in mathematics while she was an assistant in her mother's school. Their marriage was an extremely happy one. Unquestionably, he owed much to her devotion, which never flagged during his periods of ill-health and through many periods of financial difficulties. To quote again from his reminiscenses, he says, "When I began housekeeping in the spring of 1837, the inflation of prices in the time of President Van Buren had culminated. I paid $15 for my first barrel of flour; and although my salary was considered a good one, it soon became quite apparent that my expenses would exceed my income. My dear wife, instead of even intimating that it was hard for us to begin the world with expenses much greater than would suffice for a considerable family, always encouraged me in doing my duty for the relief of the dear ones whom God had made dependent upon us, saying that we might thus safely trust events to our Heavenly Father."

It soon became evident that Langstroth's health would not permit him to continue his pastorate, and at the end of three years he was forced to resign. In the spring of 1840 he accepted an invitation to become principal of the Greenfield, Massachusetts, High School for Young Ladies, and moved his family to that city. While acting as principal, he supplied the pulpit of the Second Congregational Church for nearly two years, and then became its pastor.

In 1838, during his residence in Andover, a seemingly trifling event started the chain of happenings that led to Langstroth's interest from that time on in studying the life of the bee and perfecting the art and science of beekeeping. Calling on one of his parishioners, Langstroth noticed on the table a large glass globe filled with beautiful comb honey. His comments on this resulted in a visit to the parishioner's attic apiary. "In a moment," Langstroth remembered, "the enthusiasm of my boyish days seemed, like a pent-up fire, to burst out in full flame. Before I went home I bought two stocks of bees in common box hives, and thus my apiarian career began." Langstroth does not tell us the name of that beekeeper, which is a pity, for his name should certainly be gratefully remembered since he was responsible for arousing Langstroth's latent scientific interest.

Almost the first thing Langstroth did after moving to Greenfield was to buy a stock of bees in a hollow log. Avidly he studied the few books on beekeeping available at the time, and soon became the happy owner of an improved Huber hive, and several bar hives made according to Bevan, author of Bevan's *Treatise on the Honey Bee,* published in London in 1838. Constantly he experimented in trying to make a practical hive for the common beekeeper out of the Huber hive, but got no worthwhile results. He recalled that the only improvement he was thus far able to make was to give the hives greater protection against extremes of heat and cold.

As all beemen know, the first thing one beekeeper does in a new locality is hunt up people with the same passionate interest in this insect, and Langstroth was no exception. In the neighboring town of Colrain he found William W. Cary, who had some hives, and after meeting him a deep and lasting friendship sprang up between the two men. This friend was the first of the Carys to keep bees, but ever since members of the family have kept up their interest.

The Second Congregational Church of Greenfield is next door to what was known for years as the "Hollister House," a fine example of late colonial architecture in which Langstroth con-

ducted his High School for Young Ladies. In the church yard may be seen today a beautiful bronze plaque placed there in recognition of Langstroth's contribution to beekeeping. The old New England meeting house in which he preached has been replaced by a more modern, and doubtless more efficient, building; but to many it is far less beautiful than the original white-spired house of worship.

During Langstroth's pastorate at Greenfield, he suffered greatly from frequent attacks of his head trouble, which at last compelled him to resign his charge. Now he decided to return to the home of his boyhood and open a school for the education of young ladies there. He settled his family of three small children, one boy and two girls, in a house located at the corner of Chestnut and Schuylkill Seventh streets, as it was designated in the old system of naming streets in Philadelphia. Here in the fall of 1848 he opened his school. Today, we know the location as Sixteenth and Chestnut streets.

The house had a second-story porch, or piazza, and a number of attic rooms, and these Langstroth used for the apiary he soon established for experimentation. In the rear of the lot was the customary stable where he kept his driving horse and carriage. It is difficult to visualize this corner of Sixteenth and Chestnut as an area of homes and gardens with stables in the rear, and open countryside not far away where bees could forage, for Chestnut street has been for many years Philadelphia's chief commercial thoroughfare, thronged with shoppers. It ranks today as one of the most celebrated streets in America, and virtually all signs of family dwellings have given way to shops and business offices.



Fig. 9. Descendants of Lorenzo Lorraine Langstroth at the dedication of the Langstroth Bee Garden, October 20, 1951. From right to left: Miss Anna L. Cowan, granddaughter; Mr. A. H. Cowan, grandson; Mrs. Peggy Cowan Kohler, great-granddaughter; Mr. George Cowan, great-grandson, and Mrs. George Cowan; Wm. Langstroth Cowan, grandson.

At the time of establishing his Philadelphia apiary, Langstroth had studied every known type of hive, and was far ahead of beekeepers of his generation in appreciating the necessity for a taller hive than in common use, yet one which was compact in form to serve as living quarters for the bees except during the period of crop storage. He therefore placed one hive-body on top of another.

Through his intense study of the literature on beekeeping, he learned of the work of the Swiss scientist Huber, who had succeeeded in having bees build their comb in frames which were hinged so they might be separated like the leaves of a book. Moses Quinby, the other great beekeeper of Langstroth's time, used a hive of this same general type, but Langstroth found it of little more practical value than ordinary box hives. He next experimented with hives used by the English beekeeper Bevan, and certain French and German scientists. These had the combs built down from bars which rested on the top edge of an open box. This plan presented the difficulty that the bees built the combs so securely to the sides of the box that their removal was a soul-trying operation. Langstroth found further trouble when he put on a second story, for the bees then glued the upper body tightly to the bars of the lower hive. Unless the separation was made by very careful cutting, the combs would be wrecked, and only honey in perfect comb was saiable to the public of that day.

This was where he stood in his investigations early in the spring of 1851 when he removed his apiary from his home some two miles. Working with the bar hives, Langstroth conceived the idea that if he lowered the tops of the bars a little, leaving a small space between them and the bottom of the upper box, that when it came time to cut the boxes apart, his knife would not encounter the wood of the bars and thus the task of separating the two hive-bodies would be easier. When he did this, he discovered that the bees did not fill any part of this space with their "glue" (propolis). This ⅜ inch passage is now known as a beespace, a corridor just high enough for the passage of a bee, and one that the bees leave open for access to other parts of the hive.

It seems strange that this discovery did not at once suggest to Langstroth the idea of giving the same space on all sides of the combs hanging from the bars by means of uprights fastened to them, thus changing the bars into movable frames; but it did not so occur to him and he used the convenient narrow space above the bars for a whole season without thinking of extend-

ing his idea further. In his reminiscences, Langstroth reports:

"Returning late in the afternoon from the apiary, which I had established some two miles from my city home, and pondering, as I had so often done before, how I could get rid of the disagreeable necessity of cutting the attachments of the combs from the walls of the hive, and rejecting, for obvious reasons, the plan of uprights, close-fitting (or nearly so) to these walls, the almost self-evident idea of using the same bee space as in the shallow chamber came into my mind, and in a moment the suspended movable frames, kept at a suitable distance from each other and the case containing them, came into being. Seeing by intuition, as it were, the end from the beginning, I could scarcely refrain from shouting out my "Eureka!" in the open streets. At that time there was visiting me my college classmate, the late Rev. E. D. Sanders, who afterward founded the Presbyterian Hospital in Philadelphia, and who had taken that season a lively interest in my apicultural experiments. Full of enthusiasm, we discussed, until a late hour, the results which both of us thought must come from using movable frames instead of bars. Before I sought my bed, under the date of October 30, 1851, I made this record in a private journal still in my possession: 'If the slats are made so that *a* and *b* (that is, the uprights), are about ⅜ inch from the sides of the hive, the whole comb may be taken out without being at all disturbed by cutting . . . By the very great ease with which the bars with their combs may be removed, a command over the whole proceedings of bees is obtained which is truly wonderful . . . The removal of the queen . . . and all other operations may be performed without injuring a single bee, thus preserving the apiary from constant irritation and keeping the bees always peaceable. It is obvious that the movable frames may be adapted to almost any hive, and that they will be of the greatest practical benefit.' " Langstroth may not have been properly trained in scientific methods, but he was wise enough to realize that it is imperative to record observations immediately and that those not promptly set down often become utterly worthless, because man's memory is unreliable.

One can imagine the excitement the next spring when, having moved his entire apiary to West Philadelphia to a site now part of the lovely campus of the University of Pennsylvania, he and Henry Bourquin, his apiary manager and a skilled cabinetmaker as well as a first-class beekeeper, entered upon the first trials of his invention. And their mounting exhilaration as they installed the first frame ends on the bars! The two were so absorbed in manipulating these new frames, removing them with no trouble from the hive-body and replacing them without injuring the bees, that they did not notice the presence of an old beekeeper friend who had come up and was watching them work. They did not even hear him as he spoke, until he fairly shouted, "Friend Lorenzo, you are so taken up with your new hive that you seem unable to hear me, or to see anything else. No doubt you think you have made a great invention; but I say you have made no invention. You have made *no invention* at all, but rather a *perfect revolution* in beekeeping!"

As soon as it was feasible, Langstroth applied for a patent on his invention, and it was granted in the fall of 1852. Whether he was hopeful of improving his financial condition by having his frame universally adopted, we do not know. One of the pathetic aspects of his work is shown by a letter written later by his wife begging the Commissioner of Patents to renew his patent since it had not been financially profitable to the inventor.

Because Langstroth now desired to give all his attention to his bees, he disposed of his school that spring (1852). But as had so frequently happened before, he had such a severe attack of his head trouble during the summer that he was completely prostrated. Since he could not even give instructions to his assistant, he was forced to abandon the business and sell his bees. Of this period of discouragement, he writes: "How often I can recall similar experiences, when in the heat of the race, and sometimes with the goal of success apparently almost gained, I have sunk down on the course, unable to take another forward step! I write these words with no disposition to murmur against any of God's providential dealings with me."

This ended Langstroth's life in Philadelphia, but his connection with the city was not severed. Since there was the usual pressure for money, Langstroth's wife accepted a position in the city as assistant teacher in a school for young women, which their two daughters could attend, while Langstroth went to live with the family of his brother-in-law, Almon Brainard, in Greenfield, Massachusetts. During the years in Philadelphia Langstroth had preached probably more than half his Sundays, and, when he returned to Greenfield, had sufficiently recovered his health so he soon was supplying the pulpit of the Congregational Church of Colrain nearby. He continued to do so until the fall of 1857. His wife and daughters spent their vacations with him in Colrain and his son worked on a nearby farm, and Langstroth reports each of their fam-

ily reunions as "a bright oasis in those long separations."

While living in Greenfield and Colrain, Langstroth tried with little success to sell his patented hive. But he wrote his famous book, "Langstroth on the Hive and the Honeybee." This was revised and re-issued many, many times from 1853 when it first appeared. This book was Langstroth's second great contribution to beekeeping, for, like his movable frame hive, it went 'round the world.

Between Langstroth's hive and his book, he became so widely known and respected that the two periodicals, "Gleanings in Bee Culture" and "American Bee Journal," both published his contributions simultaneously. This great respect that he engendered among beemen everywhere also made his third contribution to American beekeeping much easier than if he had not been famous. This third service to beekeeping in America was the importation of Italian bees, in which he shared. There had been sporadic attempts to import colonies, but these were at first not successful. Samuel Wagner, with whom Langstroth had been associated in other ventures, notably in an attempt to market his movable frame hive, had arranged for a shipment of Italians as early as 1855. It was made, but the bees perished on the way across the ocean. Four years later Wagner enlisted Langstroth's aid and, together with Richard Colvin of Baltimore, they ordered a colony from Italy's leading beekeeper, only to learn long afterward that the order was never received.

About this time the U. S. Department of Agriculture undertook the importation of Italian bees, and Langstroth's assistance was enlisted. He was the one who handled the single remaining Italian queen in Flushing when the first shipment arrived, and saved her. And he saved one or two others in another shipment that survived the trip a few days later.

Langstroth's later years were not happy. In 1870 his only son died; in 1872 his friend Samuel Wagner died; and in the following year his wife died. In 1874 he sold his apiary and never again had more than a few colonies at any time. His head trouble bothered him for long periods at a time, and finally his household, now consisting of himself and his daughter and her husband, Mr. H. C. Cowan, moved from Oxford, Ohio, where they had been living, to Dayton, Ohio, where Cowan's business required him to live.

On Sunday, October 6, 1895, Mr. Langstroth was to give the sermon at the Wayne Avenue United Presbyterian Church in Dayton. He was nearly 85 and his health, while it had been good of recent months, was really only fair. He mounted to the platform, where the minister had moved the pulpit to one side and provided a chair. He started his sermon with these words, "It is of the love of God that I wish to speak to you this morning—what it has been, what it is, what it means to us, and what we ought——." Lorenzo Lorraine Langstroth had completed his life.

●

## REMINISCENCES

William Langstroth Cowan

*Grandson of Lorenzo Lorraine Langstroth*

It is a little difficult to know what will interest beekeepers of today regarding the life of Grandfather Langstroth. I am not going to try to give a history of his life. That history has been written several times, and printed in the "American Bee Journal" and "Gleanings in Beeculture." Suffice it to say that he was born in 1810 and died in 1895, thus was 85 years old when he passed away.

A look at his portrait will, I am sure, tell you a great deal about his character. Kindliness, keen interest in life, and a sense of humor are evident, but I am sure you will understand when I tell you that the expressions most often used by people who see his picture for the first time are "What a kindly face"—"What a lovely old gentleman." And if a true gentleman is a "gentle man," then he was a true gentleman.

My very earliest recollection of my grandfather is revealing. In Dayton, Ohio, where he lived, the summers are extremely hot. Our drinking water came from a well—not a dug well, but a driven well, quite deep. Well can I remember Grandfather's saying, "Willie, how would you like to get me a drink? Pump it long enough so it will be cold. Get the water from the north-west corner of the well." When the pumping had been done, and the drink was

brought to him, the thanks were so appreciative that the small boy felt repaid.

One of the vivid memories that I share with my brothers and sisters is the recollection of his Grizzly Bear and Sly-Boots stories. As youngsters nothing gave us such delight as to get him to tell one of these. There was a wonderful man who was always sent for when a grizzly bear was disturbing the cattle or the country-side. Most ingenious were his methods of capturing and destroying the terrific marauder. And, often as he was called upon to tell us these yarns, never, to my recollection, did he repeat himself. There was always a new and thrilling procedure, which, at least to our childhood imaginations, was marvelously conceived and cleverly executed.

Then there was the wonderful fox who was continuously being hunted, and always eluding his pursuers. Sly-Boots was his name, and sly was his nature. Never the pack of hounds persistent enough to track him to his death.

I have often thought that if these stories could have been written in his beautiful, simple English style, they might easily have become as popular as Joel Chandler Harris' "Brer Rabbit" books. I know that they fascinated us as children, and not only us. One holiday afternoon, shortly before his death, the family were all away somewhere, except Grandfather. When we returned about six o'clock, here he was with a group of a dozen or more of the neighborhood youngsters, telling them one of his Grizzly Bear yarns. This was not an uncommon occurence.

One feature of these stories was the way they ended. Always was there some mention of honor, or thoughtfulness of others, or Christian conduct that, given with such sugar coating, was pleasant to take, and made a lasting impression on youthful minds. Nor was he lacking in stories interesting to older people. His memory was very retentive, and one story seemed to remind him of another. When in the mood, he would keep a group in gales of laughter.

As children one of our delights was to play with Grandfather's hair. It was very soft, and, being long, was easily parted, and it would part in any direction. He enjoyed having his head rubbed, and we enjoyed playing with it. He was very tolerant of our pranks, and we would part it straight across, or diagonally, and then laugh at him, and he at himself.

I have here a copy of the original patent of the Langstroth hive, of the application for that patent written by my grandmother or my mother (their handwriting was so much alike that I cannot tell them apart). Speaking of handwriting, Grandfather used to say that he had three—one anyone could read, one no one but he or his wife could read, and one he couldn't read himself when it was cold.

One of the marvels to me is where he found the time to do all the writing in longhand which he did. I have brought with me a number of letters, articles prepared for publication, etc. Those who are interested can see them at the exhibit in the Morris Mansion.

Here is a letter written to my Grandfather by his wife, my Grandmother. The time and patience required to read it, let alone the devotion to write it, speaks volumes of the industry of the older generations. Also, here is a letter from him to her. Truly our ancestors were workers. In going through his papers, the tremendous amount of time spent writing in longhand cannot fail to impress one. It is almost overpowering.

I have here also one of the books from my Grandfather's library. It is a treatise on Bees, by a Thomas Wildman, printed in 1765, and dedicated to "The Queen's Most Excellent Majesty."

I also have pictures of him at various ages, and a copy of a daguerreotype of his mother, showing a marked family resemblance.

One of my duties as a lad was to get from the public library the books which he read during



Fig. 10. William Langstroth Cowan unveiling the Lorenzo Lorraine Langstroth Memorial Bench at the dedication of the Langstroth Bee Garden, October 20, 1951.

those periods when his "head trouble," as he called it, prevented him from active work. History, biography, philosophy, and the better fiction were the books he read, and four, five, or six was a week's supply. Saturdays I used to start off with a basket of books to return, and a list of new ones to get. I have here a list of such books, found among his papers.

To you, Grandfather Langstroth is known as a beekeeper, an author, and as the inventor of the Langstroth hive. Possibly most of you know that he was very influential in the introduction into the Western World of Italian bees.

But his interests were much wider than that. He had a restless, inquiring mind, and everything interested him. His interest in Punic bees, in weather reports, in fertilizers, in horticulture, and the grafting of fruit trees, to mention only a few, was very great, and his knowledge very extensive. His Latin and Greek were of the old-fashioned, classical thoroughness, and he could read both languages fluently and understandingly. And it was as a tutor of mathematics at Yale that he earned enough to complete his theological education.

But, notwithstanding his intense concentration on matters pertaining to bee culture, never did he forget that he had been ordained a minister of the gospel. Belief and trust in God and in Jesus Christ as his personal Redeemer and Friend, was absolute, and an "ever present help in trouble."

My Father was a strict Scots Presbyterian, and his God was a strict, austere God of Justice. Grandfather Langstroth's God, on the other hand, was the God of Love. His God was a loving Father who "so loved the world that he gave his only begotten Son . . ."

On the day of his death, he was to preach the sermon at the Communion Service of our Presbyterian Church in Dayton, Ohio. An arm chair was placed near the edge of the rostrum, and he asked the indulgence of the congregation, as he felt unaccountably weary. With his kindly face, his crown of silvery hair, and his wonderful smile, he looked quietly over the gathering and said, in his usual firm but quiet manner, "I want to talk to you today of the Love of God, and of what we ought . . ." and he was gone. His last thoughts—Love and Duty.

## PROGRAM OF THE DEDICATION EXERCISES, OCTOBER 20, 1951

*Invocation* — The Reverend Burleigh Cruikshank
*Minister, Presbyterian Church of Chestnut Hill*

*Welcome to Guests* — Edwin B. Williams
*Provost, University of Pennsylvania, and Chairman of the Committee on Administration of the Morris Arboretum*

*Langstroth and the Academy of Natural Sciences* — M. Albert Linton
*President, Academy of Natural Sciences of Philadelphia*

*The New Role of Honey Bees in Our National Economy* — James I. Hambleton
*In Charge of Division of Bee Culture, United States Department of Agriculture*

*Introduction of Mr. E. F. Phillips, Jr.,* presenting the following paper completed by his father before his untimely death on August 21 — Edwin J. Anderson
*Professor of Apiculture, Pennsylvania State College*

*Langstroth—Philadelphia Beekeeper* — E. F. Phillips
*Late Professor Emeritus of Apiculture, Cornell University*

*Unveiling of the Lorenzo Lorraine Langstroth Memorial Bench* — William Langstroth Cowan
*Grandson of L. L. Langstroth*

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*The program was followed by tea and inspection of the Exhibits at the Morris Mansion.*

Gray Herbarium
Harvard University
MAR 18 1954

# Morris Arboretum Bulletin

MARCH 1954

Volume 5 Number 3

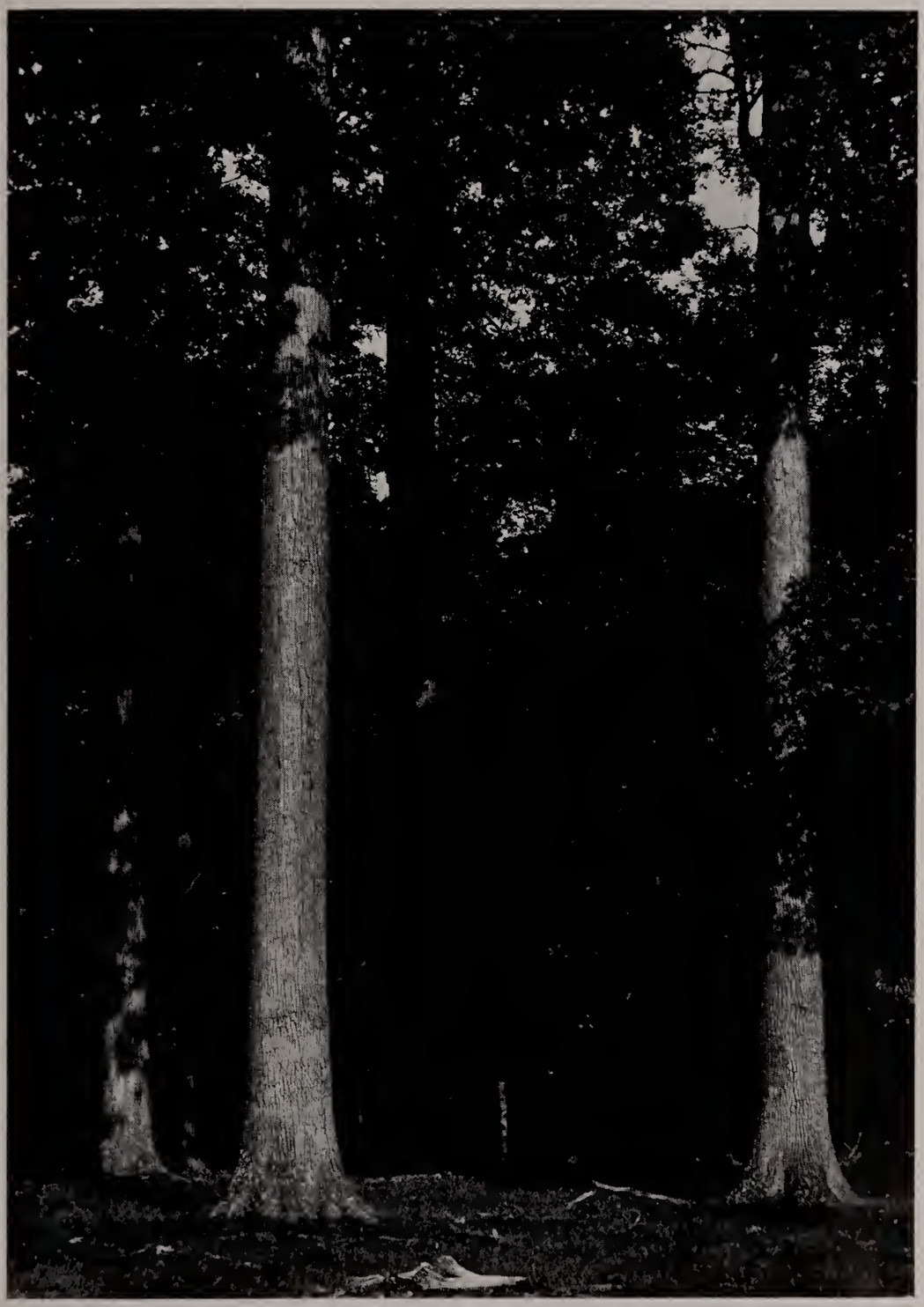


Fig. 11. White oaks *(Quercus alba)* in virgin forest, central Indiana.

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## *White Oaks of the Virgin Forest*

Of the incomparable virgin forests that once stretched virtually unbroken from the central Mississippi Valley to the Atlantic, only here and there a fragment remains. Even Pennsylvania, its name notwithstanding, presently has only a pitiably small remnant—some 7000 acres in the aggregate—of the original forest that once covered its nearly 29 million acres.

To the pioneer settler the trees were giant weeds standing in the way of agricultural pursuits. Markets for lumber in this vast area, except near population centers and ports, were in the main absent, and home consumption (fuel, buildings, fences, etc.) utilized but a small fraction of what was cut down in clearing operations. The rest—untold billions of board feet of the choicest wood—was destroyed.

As the country developed so did markets for lumber. Timber became a source of revenue, powerfully increasing the pressure on this matches primeval resource so long considered inexhaustible. How great this economic pressure has now become the frontispiece (Fig. 11) will help us to comprehend. A single virgin white oak, like those pictured on the cover and only a stone's throw from them, last summer sold for $500 on the stump! With such returns, only those of the few remaining primeval vestiges as are acquired by responsible public agencies and administered as unexploited preserves are likely long to survive.

The photograph reproduced on the cover was taken nearly a half century ago in a 160-acre tract of magnificent virgin hardwood timber some 11 miles southeast of Indianapolis near the village of Julietta, in central Indiana. In the rich soils of the lower Ohio River drainage basin many of our hardwood species grew to their maximum size. The Julietta woods, which lies in this drainage area, was a worthy sample and reminder of the sylvan grandeur that once stretched over vast areas. It is regrettable that the past tense must be used. Though the tract remains as woodland, its great trees were marketed some years after the photograph was taken. Fortunately, in a smaller woods immediately adjoining, at least twenty five magnificent white oaks of the virgin forest still remain. It was a declining member of this venerable company that recently sold for $500.

With the great oaks, including the very ones in our photograph, was fittingly associated something else—a large colony of Great Blue Herrons with their huge brush pile-like nests in the very tops of the lofty crowns. When the great oaks went, so did the herrons. We are informed that herrons are currently nesting in the remaining virgin white oaks of the adjoining tract. May their homes long remain undisturbed.

J. R. Schramm

# DAVIDIA IN THE PHILADELPHIA REGION

Davidia, or the Dove Tree, is one of the most famous trees introduced into western gardens from the mountain fastnesses of central and southwestern China during the beginning of the century. A rare and curious tree, its introduction and subsequent flowering in cultivation caused great excitement in the horticultural world. As a phylogenetically distinct stock, it is also of great interest to the botanist.

This remarkable tree was first discovered in Mupin, western Szechuan, by the famous French missionary and naturalist Abbé Armand David, in 1869. It was described as *Davidia involucrata* by Baillon in 1871, the generic name fittingly dedicated to the discoverer. A variety of this species, *Davidia involucrata* var. *vilmoriniana* Hemsley, was first collected in Wushan, western Szechuan, by another famous collector, Augustine Henry, in 1888. Subsequently Peré Farges discovered it also in northeastern Szechuan and sent seeds to Maurice de Vilmorin in France, who succeeded in raising one plant from the seeds, the first plant of this species raised from seed in cultivation.

Davidia is a medium-sized tree with spreading branches and large ovate serrate leaves resembling somewhat those of the linden tree. The inflorescences are pendulous, produced on short, lateral spur-like branches. These consist of numerous tiny naked 1- to several-stamened male flowers and one perfect (1 to several stamens and 1 pistil) flower laterally placed on the receptacle. The dome-shaped receptacle is subtended by two unequal bracts, the larger attaining a length of six and a half inches and the smaller about half as long. The bracts become snowy-white at their prime. The tree when in full bloom, with the large conspicuous bracts, is a rare sight. These pure white bracts resemble large white wings, resting or fluttering among the branches in the breeze, hence the name Dove Tree.

The variety *vilmoriniana* is very similar to the species and, except when very young, can be distinguished by its more glabrous leaves. In



Fig. 12. Flowering branch from large Dove Tree *(Davidia involucrata* var. *vilmoriniana)* at "Crosswicks" near Jenkintown, Pennsylvania.

the juvenile stage, the young shoots are dull gray or slightly purplish in the variety and dark red in the typical form of the species. It is this variety that is found occasionally in the Philadelphia region and in northeastern United States. The typical form, apparently less hardy, rarely is encountered in this area.

The famous collector E. H. Wilson first went to China in 1899-1901 for the English firm Veitch with the principal object of securing seeds of this remarkable tree, particularly the plant which later was called variety *vilmoriniana.* Wilson secured and introduced a quantity of seed which produced some thirteen thousand plants. These were widely distributed in Europe and America. His subsequent trips in 1903-04 brought back seeds of the typical form of the species.

Many of Wilson's early introductions were planted in American gardens. In northeastern United States the tree is subject to killing back to the ground in hard winters, but is often able to send out new vigorous sprouts afterwards. After attaining some size these sprouts may bear blooms, but frequent killing back makes flowering a rare event. Only very infrequently is a tree able to attain any considerable size in this region and flower profusely.

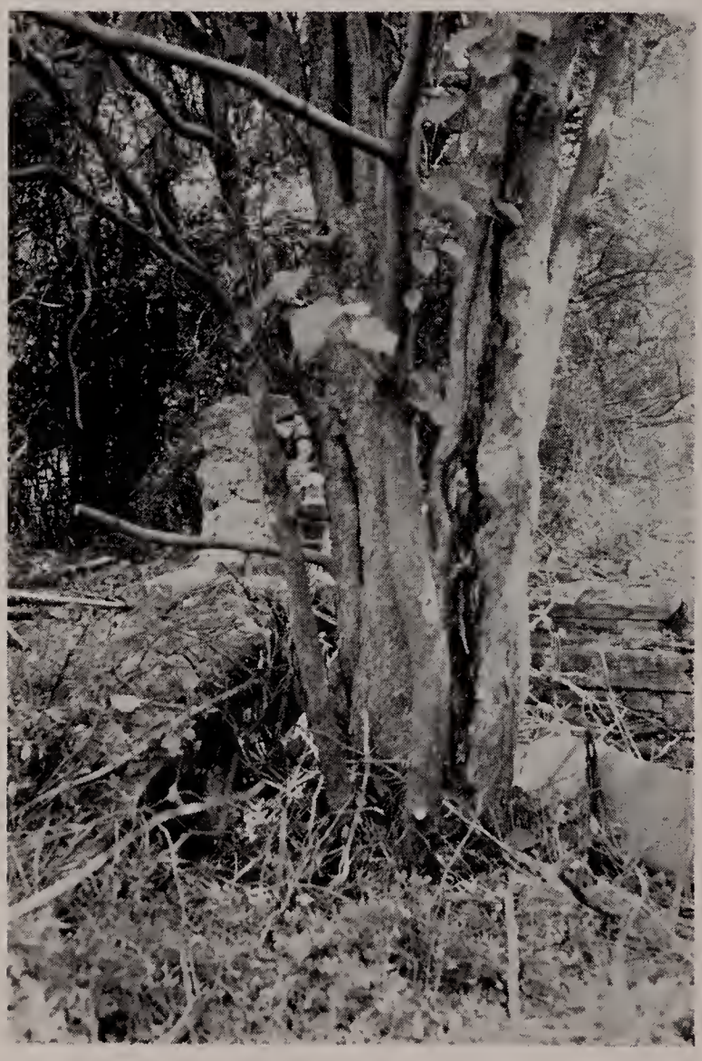


Fig. 13. Lower part of large Dove Tree *(Davidia involucrata* var. *vilmoriniana)* at "Crosswicks" near Jenkintown, Pennsylvania.

On the grounds of the Morris Arboretum there are two trees of *Davidia involucrata* var. *vilmoriniana,* one planted near the edge of a pond and the second on a slope. The latter was received in 1949 through the Arboretum of the Barnes Foundation at Merion, Pennsylvania, where Davidia is grown successfully. The other tree was planted many years ago, and is apparently a plant from Wilson's earliest introductions. It flowered in the twenties but frost-killed to the ground in the severe winter of 1933-34. The following summer vigorous shoots developed from the stump, of which one persists. Both these trees flowered in early May, 1953, but the blooms were few in number, sterile (lacking perfect flower), and of small size. Also, the bracts appeared dull white and the entire inflorescences dropped off early.

Recently there came to our notice a remarkable specimen of the Dove Tree, also of the variety *vilmoriniana,* near Jenkintown, Pennsylvania, at the outskirts of Philadelphia. Located on the former estate, "Crosswicks," of Clement B. Newbold, at one corner of a formal garden now reverted to a dense thicket of shrubs and vines, the tree is of remarkable size and in excellent health, though it has been much neglected for years. In May, 1953, it was loaded with thousands of large, fully developed snowy-white "blossoms" (Fig. 12).

The height of the tree is fully 32 feet. The main trunk, which many years ago was apparently frost-killed to a few feet above ground, measures 5 feet 7 inches in circumference. Sprouting out again, it now has two main vertical branches 3 feet 7 inches and 3 feet 4 inches in circumference respectively at breast height. These two branches in turn were winter-killed some years ago to about 12 feet from the ground, the surviving bases suffering bark injury on the south side for nearly their entire length. Subsequently the two branches produced numerous vigorous shoots which form the present luxurious crown about 30 feet in diameter. There are also a few young sprouts arising from near the ground level. The lower part of the tree appears in Fig. 13.

This tree, as far as can be ascertained, was planted in the early 1900's from Wilson's first introductions, and is thus of the same age as the older one at the Morris Arboretum. Around 1925 the flowering of these two trees attracted considerable attention locally.

In May, 1953, this large "Crosswicks" tree flowered in great profusion. The bracts were of large size and of dazzling whiteness. The inflorescences, nearly every one of which bore among the staminate flowers the single perfect flower normal for Davidia, did not fall off as did those on the Arboretum trees. The bracts were not only larger and whiter but all were strictly entire. On the other hand, in the inflorescences on the Arboretum trees the margins of the bracts were serrate as in the foliage leaves.

The close relationship between the bracts and the foliage leaves is also indicated by other phenomena observed in this larger tree. Some of the leaves bore large elongated tips of snowy white color as in the bracts. Normally the bracts are sessile whereas the leaves are long-petiolate. On one floral branch there were two inflorescences instead of the usual one, with 2 bracts in one and 4 in the other. At the middle of the peduncle there was an additional very large bract which was white and entire but long-petiolate like a leaf. Other floral anomalies included 3 or 4 bracts per inflorescence instead of the usual 2, and the presence of 2 perfect flowers on a single receptacle instead of one.

On this larger tree, as well as on the other smaller trees observed, there occurred some partially discolored leaves which were at the same time sparsely-serrate or nearly entire. These leaves were nearly always the uppermost ones of the short branch bearing them. Blanching always occurred at the margin or in the outer part of the leaves, varying in shade from creamy white to light green. All these represent transitional stages between foliage leaves and bracts.

Also at Crosswicks there is a second Dove Tree but of much smaller size. It is apparently of the same age as the larger specimen, but the original trunk was evidently frost-killed to the ground years ago. At present the plant consists merely of some 5 or 6 vigorous shoots. These also bore some flowers in 1953 but the bracts were small, often with teeth, and all the inflorescences lacked perfect flowers and were shed immediately after flowering, as was the case in the two plants at the Morris Arboretum.

The larger Crosswicks tree bore quantities of well developed fruits in 1953. Unfortunately, nearly all were devoured or damaged by squirrels before fully ripened.

Wilson, studying the tree in the wild in China, records the maximum height found as 65 feet and the greatest trunk circumference as 6½ feet. The larger Crosswicks tree, which has a trunk circumference of 5 feet 7 inches, is thus only 11 inches below the maximum found by Wilson in its native habitat. In height it is about half the maximum noted by Wilson in China. But for the major killing back by severe cold on two occasions (Fig. 13) the tree now would surely be substantially taller — perhaps even rivalling the maximum observed by Wilson in its Oriental home.

However this may be, there can be no doubt that in the company of Davidias existing in the Philadelphia area the Crosswicks tree must be considered a venerable and distinguished member. It has been through battles with its antagonist—extreme cold. Though bruised, it has rallied each time and is facing the future in a reassuring state of health and vigor. Further setbacks may be in store for it. But for a half century it has not merely survived but responded with vigorous rejuvenation after each buffeting. There is thus every reason to believe that this specimen is biologically equipped to hold its own in our climate, certainly in its present location, and suffer only temporary setbacks in the severest winters which the Philadelphia area is likely to experience.

One wishes that this little account might end on this happy note; unfortunately it must close on one of apprehension. This exquisite rarity is in danger. The Crosswicks acres are in the midst of an extensive housing development. The threat of destruction is imminent. Some way should and, it would seem, must be found to preserve this remarkable tree. The immediate community, the Philadelphia area, and the development itself will be enriched thereby.

Hui-Lin Li
J. R. Schramm

# THE CHINESE TULIPTREE (Liriodendron chinense) IN NORTHEASTERN UNITED STATES

Hui-Lin Li
*Research Associate, Morris Arboretum, University of Pennsylvania*
Jonathan W. Wright
*Geneticist, Northeastern Forest Experiment Station, U. S. Forest Service*

There are two species of tuliptree, the American (*Liriodendron tulipifera* L.) and the Chinese (*L. chinense* [Hemsl.] Sarg.). The first is a large and important timber tree widely distributed in eastern North America, growing to a height of 150 feet. The Chinese tree is a small (60 feet), relatively unimportant forest tree in parts of western Hupeh and northern Kiangsi in central China.

The botanical history of the Chinese species is interesting (Wilson, 1905). It was first collected in 1873 at Lushan, near Kiukiang in northern Kiangsi, by the British medical missionary Shearer. Moore (1875) tentatively identified it as a new species in 1875, but it was not named. The discovery in a remote part of the world of a tree belonging to a genus hitherto considered monotypic and endemic to America was so astonishing that many believed its occurrence in China probably was to be explained as an introduction from the New World. A little later Maries collected flowers in the Lushan Mountains; and Hemsley named the tree *Liriodendron tulipifera* L. var. ? *chinense* Hemsl. (Forbes & Hemsley 1886). Only then was it certain that the tree was not a recent introduction from America.

A little more material was collected by Henry and Wilson in western Hupeh, and in 1903 Sargent (1903) gave the tree a species name of its own, only 2 weeks before Hemsley likewise raised it to specific rank (Hemsley, 1903). Since then other taxonomists (Wilson, 1905; Elwes and Henry, 1911; Bean, 1919) have upheld Sargent's species. And to the smaller flower and fruit size that Sargent considered the only distinctive characteristics, they added deeper leaf-lobing, smaller stature, and bushier form as distinguishing features.

The tree was first introduced into England and North America in 1901 (Wilson, 1905) as a result of Wilson's collecting in western Hupeh. As far as known there is only one living specimen in the United States from this introduction —a 30-foot tree growing in a protected location in the Brooklyn Botanic Garden. Even to the trained observer it appears much like a poorly growing specimen of the American species. The tree flowers occasionally—not every year as does the American tree.

In 1948 a new introduction was made from Lushan Botanic Garden through A. G. Johnson of the Arnold Aboretum. Seed from this collection (Northeastern Forest Experiment Station No. NEG 462) was obtained for testing by the Morris Arboretum. The seed germinated in 1949, and seedlings were grown in the Morris Arboretum's experimental nursery in comparison with native tuliptrees of local origin.

Up until the end of the second year the two species were distinguishable only by slight differences in their leaves. By the end of the fifth year, however, the Chinese trees were easily recognized by their repeated dieback—usually to the ground. This was probably due to winter cold, although it may have been accentuated by scale (*Toumeyella liriodendri*) and fungus attack. *Phomopsis* fruiting bodies were present on the dead twigs (Dr. Alma Waterman, personal communication). On the native species growing in the nursery neither pest caused appreciable damage.

Growth vigor of the American and Chinese nursery stock at the Morris Arboretum is compared in the following tabulation:

| Species | Average height | | Leaves per tree, fifth year |
|---|---|---|---|
| | Second year | Fifth year | |
| | *Cm.* | *Cm.* | *No.* |
| Chinese | 64 | 65 | 20 |
| American | 54 | 318 | 305 |

To study the taxonomic characters of the two species, the largest leaf was collected from each of 13 Chinese and 6 American trees, all 5 years old. The two species compared as follows:

| Species | Length of leaf blade | Blade length | Petiole length | Distances between sinuses |
|---|---|---|---|---|
| | | Blade width | Blade length | Blade width |
| | *Cm.* | *Ratio* | *Ratio* | *Ratio* |
| Chin. | 9.4 | 0.75 | 0.80 | 0.33 |
| Amer. | 11.5 | .77 | .76 | .48 |

The small size of the Chinese leaves was due mostly to the poor vigor of the trees. Of the quantitative leaf differences, only relative depth of sinuses was significant. Several qualitative differences were also noted: The branchlets of the Chinese trees were grayish, with more lenticels; the leaves were thinner, easier to dry, less glossy, and purplish in late summer, turning yellow in the fall. The branchlets of the American trees were reddish and the leaves had a reddish autumn color.

Of all the vegetative differences noted, only the dieback and the relative depth of sinuses were sufficiently pronounced to enable one to identify a Chinese tree with certainty if found without a label in a native woodland.

A 2n chromosome count of ca. 38 made on aceto-carmine root tip smears of the Chinese plants agrees with the number reported for the American species (Whitaker, 1933).

Some of this same stock (from the 1948 seed from Lushan Botanic Garden) was outplanted at three different locations: Beltsville, Maryland; Philadelphia, Pennsylvania; and Williamstown, Massachusetts. The planted trees resemble those remaining in the nursery save that mortality has been higher. Of these outplanted trees, 1 of 18 survives at Beltsville, 3 of 11 at Philadelphia, and 2 of 3 at Williamstown. The trees at Williamstown have suffered only winter injury, and are the healthiest of the lot. At Beltsville 41 of 48 American tuliptrees planted at the same time survive and are healthy.

In view of our nearly complete failure with the Lushan trees and the doubtful success of the Brooklyn Hupeh tree, there seems little hope of utilizing the Chinese tuliptree in the Northeastern United States as a species; possibly it will be useful as a parent in hybrids.

But perhaps the American species would be of value in China. It is generally a better tree and seems more adaptable. It is grown to some extent in northeastern United States and in Japan, and is quite successful in arboreta in the milder portions of northern and central Europe.

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# A REEXAMINATION OF PLANT LABEL PROBLEMS, WITH SOME NEW DESIGNS

J. R. Schramm

For the experimenter, propagator, nurseryman, etc., for whom labels serve usually as short-time on-the-spot records of plants in the greenhouse, frames, nursery, or field, existing types fulfill all essential needs. On the other hand, for permanent plant collections serving public educational objectives, labeling presents special problems not all of which have been satisfactorily resolved. Faced some years ago with the task of relabeling many plants, especially at the Morris Arboretum, the matter was reexamined with some care with the result that a series of labels was designed and fabricated. Large numbers of these have now been in use for from eight to fifteen years—long enough to assess their performance and render a report. In doing so no claim is made that all the problems have been solved. It is hoped, however, that a modest contribution has been made toward the solution of at least some of them.

It probably is not difficult to reach substantial agreement on the attributes the ideal label should have. Doubtless these would be something as follows: (1) Visibility; (2) legibility; (3) permanence; (4) absence of injurious effects on the plants; (5) low initial cost; (6) low maintenance cost; (7) absence of appreciable intrinsic value tempting to the thief; (8) attractiveness.

Obviously some of these attributes are interrelated, such as initial cost, permanence, and maintenance cost. Low initial cost may not be economical in the long run if achieved by sacrificing long life. To keep public educational collections adequately labeled is at best difficult. If because of short life, early deterioration, or other shortcomings labels require frequent replacement, refurbishing, or other unduly time-consuming and costly attention, sooner or later the labeling of collections is likely to fall into disrepair. And because of the cost and time involved, restoring it to good order may suffer protracted delays. Many valuable collections have experienced these ups and downs in labeling. In the label designs to be discussed, initial cost has definitely not been the overriding consideration. Rather, low cost over the years and the optimum of desirable attributes in general have been the prime objectives.

Since the problem of the Morris Arboretum concerned mainly woody plants, the designs are primarily for trees and shrubs. However, some attention was devoted also to permanent greenhouse collections, special out-door plantings, and a variety of situations requiring appropriate adaptations. In all the labels the materials are the same—stainless steel and black locust wood *(Robinia pseudoacacia)*, one or the other or both being used in any given design as required. These materials were chosen because of proved long-lasting qualities. The designs of the labels are such that the wood can be replaced by metal or plastics if desired. In the absence of long successful experience with plastics out of doors, the Arboretum thus far has not used them.

Details of materials, fabrication, and equipment employed in producing the various types of labels will be furnished in a concluding appendix. But meanwhile the invaluable services of Mr. George Campbell of the Morris Arboretum are gratefully recorded. The successful development of fabricating methods and devices is largely the result of his ingenuity and skill. In addition, Mr. Campbell has contributed valuable features in the label designs.

The labels to be described are the following:

Tree trunk label with screw attachment.

Tree trunk label with expanding band attachment.

Hanging label for shrubs, small trees, woody vines, etc.

Removable standard label anchored in the ground for situations where plant-attached labels are not practical; also for special display collections.

Label for greenhouse, rock garden, bedding, etc., plants.

## I. TREE TRUNK LABELING

The labels designed for tree trunks are of wood, and are of two types as regards mode of attachment. (1) For trees with sufficiently thick and firm cork (e.g., black walnut), screws penetrating the cork no deeper than the cork cambium fasten the label to the trunk (Fig. 14). (2) For trees with shallow cork (e.g., Fagus, Abies) or with loose shedding cork (e.g., some hickories), nothing is driven into the trunk; instead, label attachment is effected by means of a self-adjusting band encircling the trunk (Figs. 15 and 16).

These designs are the outgrowth of an attempt to bring into harmony the mode of at-




Fig. 14. Design of tree label attached to bark by screws anchored wholly in the cork. For details see Fig. 21.

tachment with the developmental anatomy of tree trunks. The well known difficulties experienced with tree labels (overgrowing of the label by the growing trunk; pushing over the heads of attaching screws or nails; initiation of decay; etc.) spring from a conflict between the mode of attachment and the growth habits and processes of the trunk. Since interest in tree labels is not confined to those thoroughly conversant with the precise nature of these processes, a brief review of the essential relevant facts of trunk growth may not be out of place.

### A. Developmental Anatomy of Growing Tree Trunk

For our purposes the trunk falls naturally into the following main regions (Fig. 17): (1) the central cylinder of wood, surrounded by (2) the bark, with (3) the all-important cambium constituting the thin boundary between the first two.

By way of locating these three areas in everyday experience it may be recalled that when the bark is peeled from a trunk the separation usually occurs at or approximately at the cambium. The same discovery, albeit with more thrill, has been made by anyone who in mid spring has fashioned a whistle out of a willow, pawpaw, or other suitable twig. The gentle pounding of the peripheral bark of the twig is more than a ritual; it serves the essential purpose of crushing the very delicate newly formed tissues at the region of the cambium. As a result the entire central wood cylinder can be pushed out, leaving the bark intact as a hollow cylinder. Tempting as it is it would take us beyond our purpose to pursue further the gentle art of whistle making and virtuosity, including such fine points as raising and lowering the pitch by sliding the wood cylinder respectively toward or away from the fashioned "blow" end, reminiscent of a sliding trombone. But enough has been said to identify quite precisely in non-botanical terms what is bark, wood, and the location of the cambium.

The cambium, although completely encircling the wood cylinder, is minute in radial thickness.



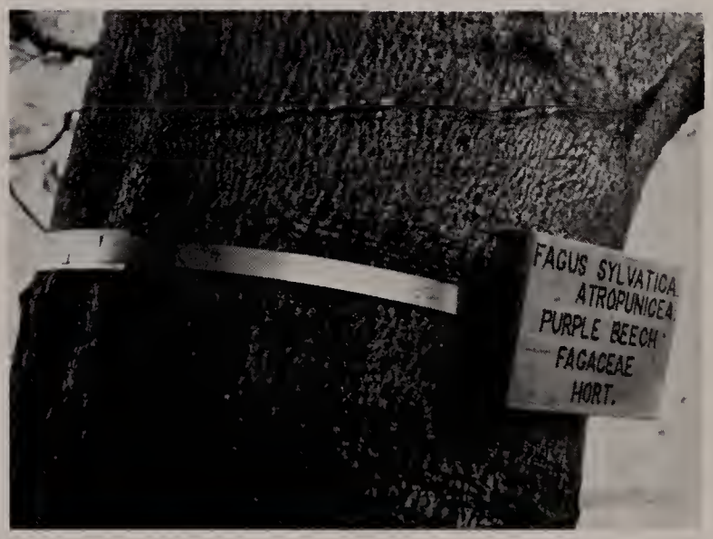




Fig. 15 and 16. Design of tree label attached to trunk by automatically expanding band. The photographs show respectively the two ends of the functioning band assembly. For details see Fig. 22.

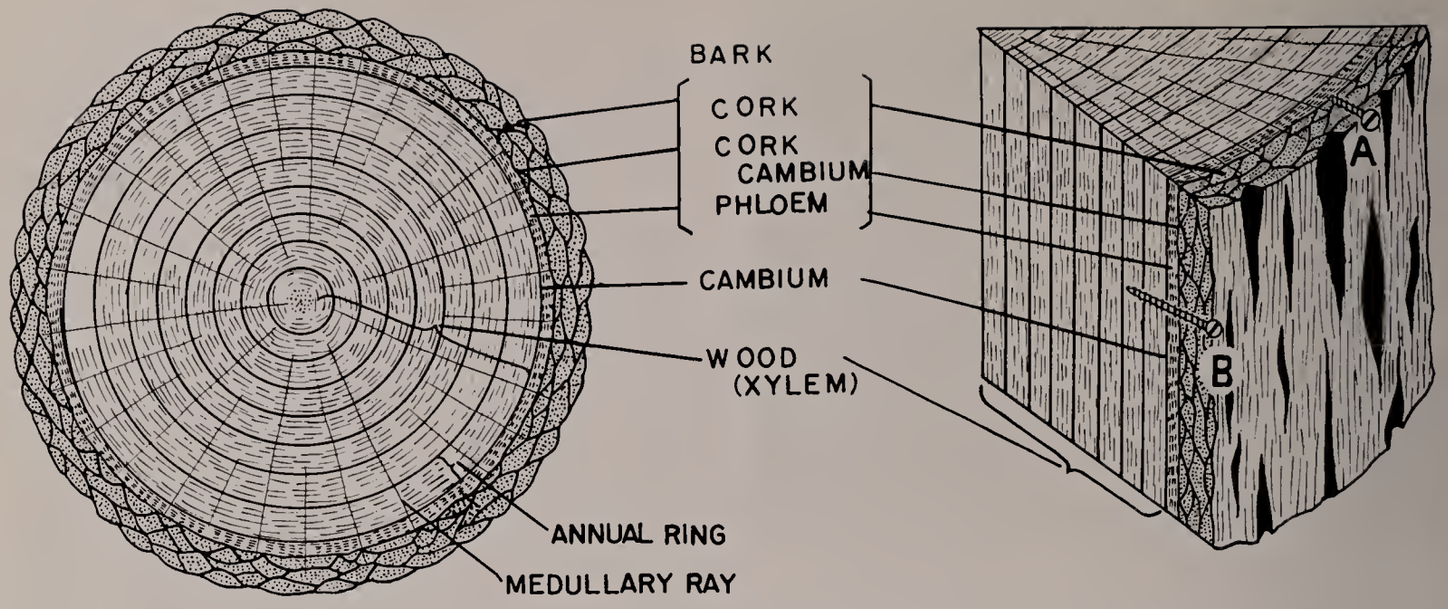



Fig. 17. Tree trunk eight years old showing schematically its three main regions: (1) The wood or xylem; (2) the bark, consisting of cork, cork cambium, and phloem; and (3) the cambium. Left, a cross section in two-dimensional view; right, a pie slice in three-dimensional perspective.—*Drawing prepared by Dr. Hui-Lin Li, Research Associate of the Morris Arboretum.*

It may be envisioned as a microscopically thin and very delicate membranous tissue occupying precisely the boundary between the outer limits of the wood and the inner limits of the phloem (the latter the innermost region of the bark), with both of which it is at all times in the closest organic and living union. This position between wood and phloem is maintained throughout the life of the tree, whether the wood cylinder be a fraction of an inch in diameter or measured in yards as in a giant Sequoia. Thus, as the wood cylinder enlarges with growth the cambium moves out with it, constantly shifting its *absolute* position. But it never changes its *relative* position—always does it occupy the boundary between wood and phloem. To do this it obviously itself must and does grow tangentially, accommodating itself perfectly to the steadily increasing circumference.

The justification for dwelling on the cambium is that it is responsible for nearly all growth in thickness of the trunk, indeed of limbs, branches, twigs, and even of roots. In the growing season its minute cells divide tangentially, each into two cells — an outer and an inner. The inner ones (next to the wood) may speedily grow into typical wood cells, in which case the outer ones remain as cambium cells; or the outer ones may grow into characteristic phloem cells, in which instance the inner ones remain as cambium cells. This process repeats itself many times during the growing season. Thus the cambium generates on its inner face additional wood (strengthening and water-conducting tissue) and on its outer side additional phloem (conducting tissue for elaborated foods), but always the vital cambium persists at the boundary between the two. Obviously, the most recently formed wood is always at the *outermost* limit of the wood, whereas the newest phloem tissue is always at the *innermost* limit of the phloem.

Actually the volume of additional wood generated by the cambium in a growing season is much greater than the volume of new phloem produced in the same period. Moreover, the wood produced by the cambium early in the growing season is in many species conspicuously porous (large cells) whereas the wood generated toward the end of the growing season is denser (smaller thicker walled cells). Thus when wood production starts in the spring, there is an abrupt transition from the dense wood produced late in the previous season to the porous wood generated early in the current season. In this manner are produced the well known "annual rings" of wood so conspicuous in many of our trees.

For present purposes another growth process is important which meanwhile is taking place in the bark (Fig. 17). The outer portion of the bark consists of a substantial layer of protective cork. This, too, is formed by a cambium—the *cork cambium*—located at the inner limits of the cork. Dividing tangentially much as the cambium cells, the outer cells so formed are converted into cork cells, the inner ones perpetuating the cork cambium. (The cork cambium generates a little tissue also on its inner face; how-




Fig. 18. Lead label, attached by a nail driven into the wood, in process of being pushed off over the large nail head.

ever, for present purposes it is unimportant and need not be traced further.)

Matured cork is a dead tissue. As such its cells cannot divide and grow to accommodate the cork to the constantly enlarging trunk circumference. In consequence the cork breaks in a great variety of ways, producing the surface bark configurations so characteristic of tree species:* deep vertical furrows and prominent firm ridges as in black walnut and tulip poplar, loose flaky scales as in apple and spruces, thin layers shed annually as in sycamore, vertical hanging plates as in shagbark hickories, etc., to mention only a few. Still other trees develop very little cork, the bark in consequence remaining thin and smooth with little or no shedding, as in beech, true firs, Carpinus.

With these facts in mind we return to the problem of attaching labels to trunks. Quite naturally the all but universal procedure is to drive screws or nails into the trunk, that is, through the bark and into the wood. This provides firm attachment, but it also invites trouble.

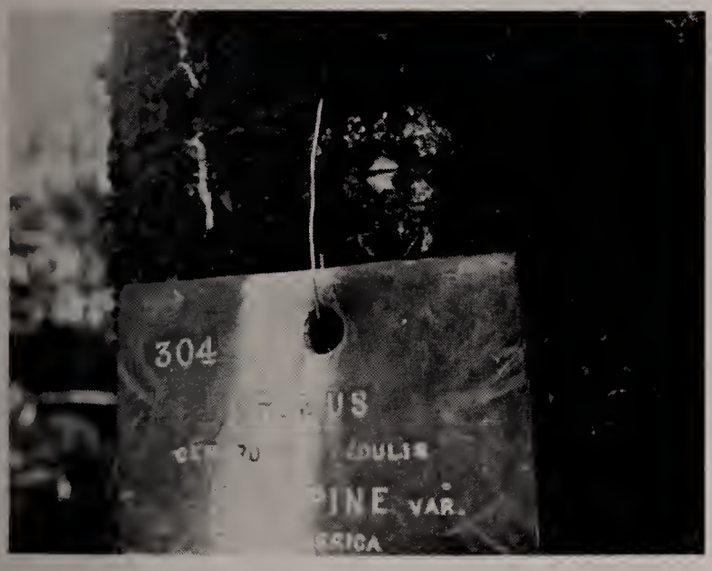



Fig. 19. Lead label pushed off over the head of its erstwhile attaching screw and fallen to the ground (resuspended for purposes of the photograph). The screw, anchored in the wood, all but completely engulfed by the bark.

*These configurations are determined by anatomical and developmental facts which need not be detailed here.



Fig. 20. Label attached by a nail driven into the wood. In this case the lead label was not pushed off over the nail head; instead, it was folded back on itself by the growing trunk and is in process of being swallowed up.

A screw or nail so situated (Fig. 17 at B) is anchored at its far end in the wood. During the growing season the cambium adds new wood and new phloem in the manner already described. This new tissue interpolated by the cambium pushes the bark outward. But the nail or screw, being firmly anchored in the stationary wood, does not move outward with the bark but maintains its initial absolute position. In consequence the nail or screw is eventually completely overgrown. And meanwhile the label is either pushed off over the head (Figs. 18 and 19) or, failing this, is also engulfed (Fig. 20).

Various procedures are used in attempts to mitigate these difficulties, such as periodic outward adjustment of the nail or screw to keep ahead of the encroaching bark. The adjustments to be effective must be made regularly; unfortunately they may be difficult if not impractical to make. The newly developing tissues are molded so intimately and firmly about the nails or screws that the latter, even if not corroded, are likely to be "frozen."

At the Morris Arboretum, too, decay has occasionally set in about nails and screws used in attaching labels. In some instances these have been very valuable—even unique—trees.

All in all, in restudying label design an attempt has been made to avoid the difficulties and hazards attending the traditional mode of attachment by screws and nails. Again referring

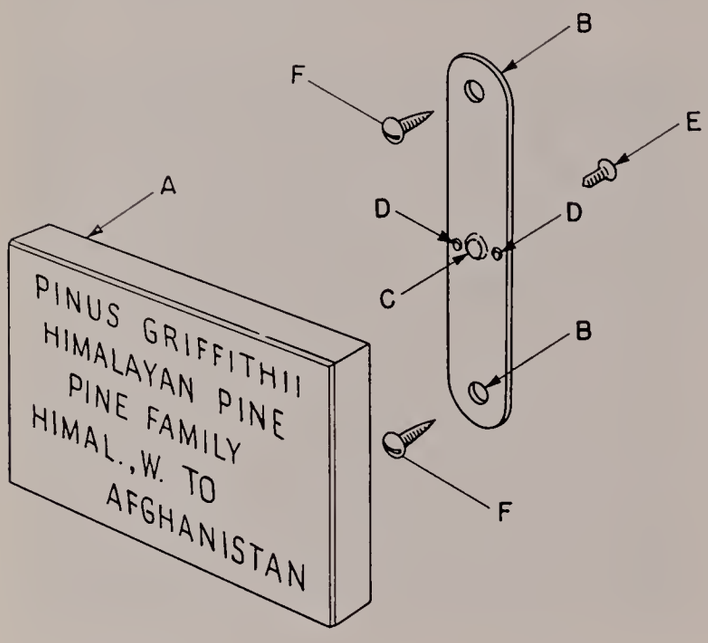



Fig. 21. "Exploded" view of trunk label design for attachment to the cork. A, inscription-bearing black locust wook block. To the right, the stainless steel attaching strip B: C, countersunk hole for attaching strip to block by screw E; D, D, countersunk holes, the projecting burs fixing the strip at the desired angle with reference to the block when screw E is tightened; B, holes for screws F, F, anchoring the assembly to the bark (screws do not penetrate beyond the cork).—*Drawing Courtesy H. L. Yoh Company, Inc., Philadelphia, Pa.*

to Fig. 17, a practical procedure at once suggests itself for trees with suitable bark which, although employing screws, avoids the above difficulties.

The screw at A is anchored wholly in the cork. The cork being dead, the screw at no time enters living tissues, thus avoiding the hazard of initiating decay. But more important, the screw is never in danger of being overgrown. All the new tissues formed by the cambium and the cork cambium are laid down within the innermost anchoring point of the screw. In screw B, on the other hand, the new tissues are wedged in *between* the tip of the screw (anchored in the wood) on the one hand and the head on the other. Since the anchor in the wood holds firm, the screw keeps its initial *absolute* position and eventually is engulfed. Screw A, on the contrary, rides outward undisturbed as the trunk grows, constantly shifting its *relative* radial position while keeping its initial position in the dead cork.

It is apparent that only on tree trunks with sufficiently thick, firm, and non-shedding cork is it practical to employ the label designed for screw attachment (Fig. 14). For trunks with cork not meeting these specifications, the corresponding label design (Figs. 15 and 16) avoids screws and nails altogether and employs instead a self-adjusting band encircling the trunk. The band attachment can be used as well on all trees for which the screw attachment is practical. However, since the latter is simpler to fabricate and many species have suitable cork, the screw-attached design is widely used in the Arboretum and is therefore included in the general descriptions that follow.

### B. Trunk Label With Screw Attachment (Fig. 21)

a. *The Wood Label.* — For most purposes a locust wood block 3″ x 5″ (¾″ or ⅞″ thick) is adequate; larger sizes can be used where necessary. The engraving is done with a power router in letters 5/16″ or 3/8″ high—large enough to be easily read though the label is attached well above arm's reach. Besides its phenomenal durability, locust wood has another important advantage. Being very hard, the high speed routing bit scorches the sides and bottom of the channel as it cuts. The result is a durable charcoal inscription requiring no tinting.

b. *The Stainless Steel Attaching Strip.* — To the back of the label a strip of steel is attached by a single centrally placed screw. This strip is so designed that within certain limits the label can be kept horizontal whatever the angle of the trunk or large limb to which it is attached.

c. *Fastening The Label To The Trunk.* — Attachment of the assembled label to a favorable cork ridge is effected by two screws of a length not penetrating beyond the cork. In some species with thin but very firm cork, e.g. red oak, ¼″ screws are holding well, though they are not recommended except in such very favorable cases. One naturally uses the longest screws that the cork will accommodate; however, it has not seemed necessary to exceed ¾″.

d. *Performance.* — Some hundreds of these screw labels have been in use for the past eight

to twelve years. During this period the labels on an occasional tree came loose because the nature of the cork was misjudged. In 1953 all were critically examined—the first systematic inspection since installation. In a few, slightly larger screws were substituted, the original ones having loosened (or rarely the labels were shifted to neighboring cork ridges). In other instances the screws, while firm in the cork, were tightened slightly. But the great majority required no adjustments whatever. A new type of screw has now been adopted (details in the appendix) which will reduce still further the number and frequency of adjustments.

In no case did the label itself show any deterioration. As expected on anatomical and developmental grounds, pushing off or overgrowth of labels was completely absent. And in no instance had decay been initiated in the tree. Using good judgment initially in selecting only trees having suitable cork, one such inspection in a minimum of five years should keep the screw labels in excellent order. For the hundreds of these labels in the Arboretum scattered over some 75 acres the inspection at the end of eight to twelve years of service required the time of one person for about two days. All adjustments were made on the spot. No label required replacement or other attention indoors, and it is expected that this will continue to be so for decades.

### C. Trunk Label With Self-adjusting Band (Fig. 22)

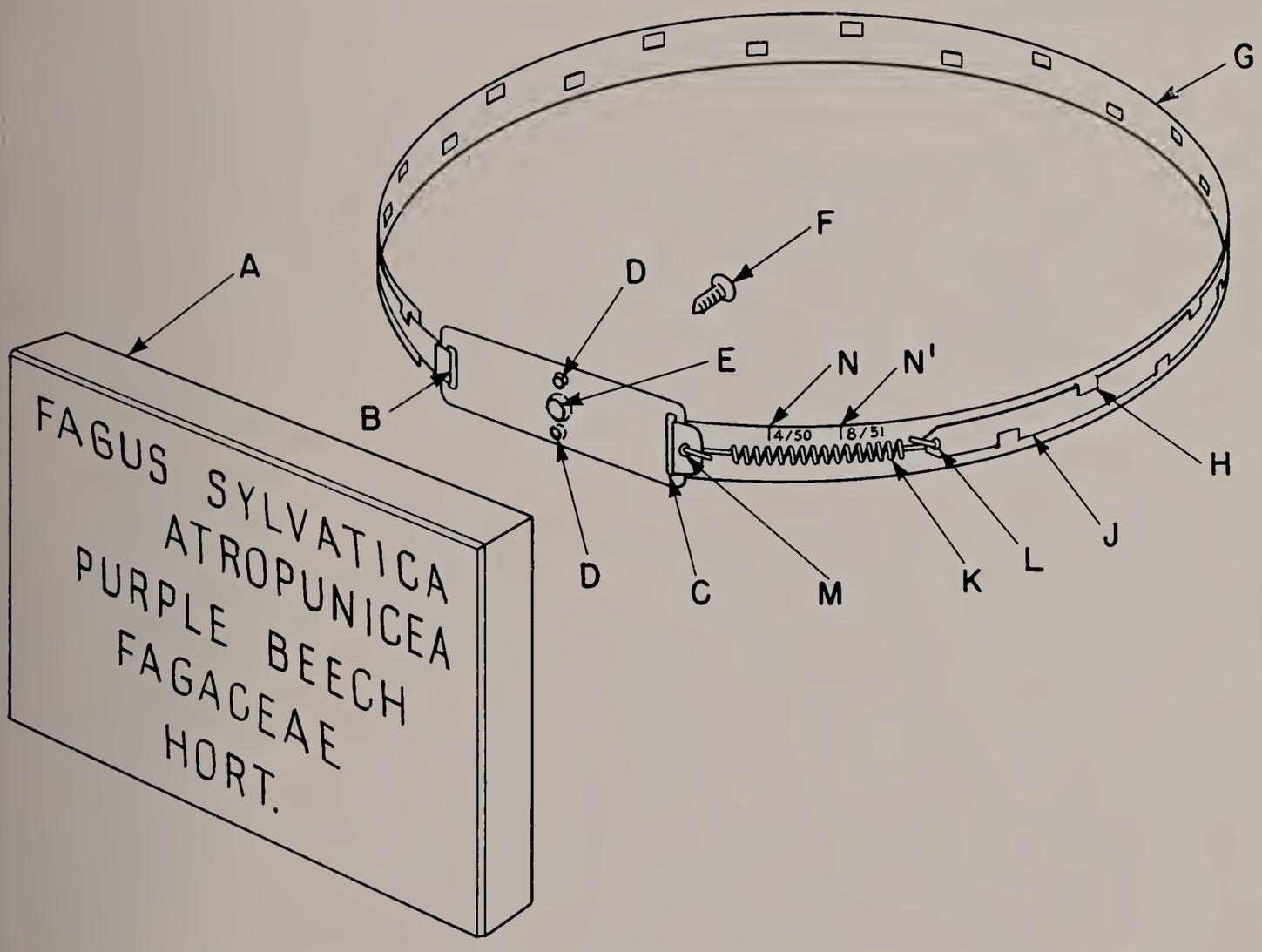



Fig. 22. "Exploded" view of tree label attached to trunk by self-adjusting band encircling the trunk. A, inscription-bearing black locust wood block. Just beyond, the stainless steel strip attached to the back of the block: E, countersunk hole through which screw F anchors the strip to the block; D, D, countersunk holes, the projecting burs fixing the strip at any desired angle with reference to the block when screw F is tightened (see Fig. 23); B and C, slots for anchoring ½" band J and ¾" band G respectively. H, staggered and opposing lugs in wider band G to form channel in which narrower band J slides. K, spring anchored in holes M and L, completing the assembly. Records at N and N¹ furnish growth data (for details see text). *Drawing Courtesy H. L. Yoh Company, Inc., Philadelphia, Pa.*




Fig. 23. Label firmly fixed in horizontal position whatever the angle of the trunk or limb to which expanding band is attached. For details see Fig. 22.

a. *The Wood Label.* — The wood label is in all respects indentical with the preceding, the difference in this design being wholly in the mode of attachment. Though developed originally for trees lacking bark suitable for screw attachment, it is practical on nearly all trees five inches or over in diameter and can therefore replace the screw label if desired.

b. *The Attaching Device.* — The principle of the attaching mechanism is apparent from Fig. 22. To the back of the wood block is fastened a steel strip, again by a single centrally placed screw. To one end is anchored a ½" steel band long enough to reach nearly around the trunk. To the other end is attached a ¾" band of sufficient length almost to encircle the trunk in the opposite direction. The wider band is prepunched with opposing and staggered lugs, forming a channel within which the narrower band slides. With the narrower band threaded under the lugs of the wider one, a length of stainless steel spring joins the two bands into a single system and puts the entire assembly under sufficient tension to hold it securely in position on the trunk.

As the trunk grows and exerts pressure on the encircling composite band, the latter adjusts itself automatically through the sliding of its two component bands, though always kept under tension by the spring. Throughout, the lugs keep the elongating spring in position on the midline of the wider band. And as the spring is extended more and more the tension increases, so that continued snugness of the encircling band is assured.

Even if it were practical on other grounds, which it is not, to achieve the same automatic adjustment by simply using a stainless steel spring encircling the trunk, it often would fail because of overgrowth. A spring lying directly on the bark exerts its entire pressure in the narrow line along which it touches the bark. This highly localized pressure, increasing as the spring is stretched, eventually stimulates the underlying living tissues, especially in thin-barked trees, to overgrow the offending spring. When, on the other hand, the spring lies on the steel band the same pressure is distributed evenly over the entire area under the encircling band. So distributed the pressure nowhere becomes sufficient to stimulate the slightest abnormal growth.

As a byproduct, the band device serves as a very fair dendrometer. The position of the free end of the narrower band is recorded by a vertical lead pencil mark on the wider band, adding the date and year (Fig. 22, N).* Annually thereafter, or at other desired intervals, the new position of the end of the narrower band is similarly recorded (Fig. 22, $N^1$,) the distance between the two being the circumferential growth during the interval. (If a forester's diameter tape is used, circumference measurements are read off directly in terms of diameter increment.) When bands are first attached to trees, conformity to the trunks is not perfect and some slack remains. Usually one year's growth takes up all this slack, after which movement of the end of the band is a measure of circumferential growth. In very slow growing trees it may be safer to wait two years before recordings are begun.

Lead pencil for these records is recommended advisedly. The surface of the stainless steel is microscopically pitted and takes pencil marks admirably. Based on 15 years' observation, weather is totally without effect on such records. However, they can be removed easily with an ordinary rubber eraser. This is not without significance, because outgrown bands can be reused on smaller trunks where again they can furnish dendrometric data free from confusion with earlier records.

One other secondary advantage the band-labeled tree has: it proclaims the welcome information that it is in fact labeled, whatever the direction from which the visitor approaches it.

c. *Performance.*—Some hundreds of the band labels have been in use for from 7 to 12 years. In the earliest ones the spring anchors were improperly designed and in some cases disengaged. With improved design no further such difficulty has been experienced. In three cases the bands failed to function after several years, and for

*If preferred, the position of the free end of the wider band can be recorded on the narrower band.

interesting reasons. In an Eastern White Pine, snow breakage several years after the label was installed necessitated removal of branch stubs above the level of the label. Resin poured from the wounds, running down the tree and over the bands. When the volatile matter had evaporated the bands were "frozen" in the solid residual rosin and unable to move. After a time trunk growth tore the wider band loose from its attachment. In a parallel case on a Norway Spruce badly diseased with Cytospora canker, copious resin exudation similarly resulted in "frozen" bands. In the third case (Cercidiphyllum) the band was so placed that at one point it lay in the upper acute angle made by a major branch with the trunk. When the bark of the enlarging branch made contact with the thickening trunk in this narrow angle, the band was caught in a vise. Aware of this possibility in certain species, it is easily avoided by properly locating the band.

Not until 1953 when the screw labels were inspected were all the band labels likewise critically examined. No other functional difficulties were found, and no deterioration either in the labels or the attachment mechanism was detected, nor does any seem in prospect. The only attention required — in a few rapidly growing trees — was the replacement of the outgrown bands (the component bands disengaged or about to be disengaged at their free ends by the growth of the trunk) with a new spring and band assembly of appropriate length. As in the screw labels, no sign of overgrowing or other induced abnormal growth was detected. And as would be expected from the mechanical principle of the band, no other injury of any kind had occurred.

*(To be continued)*

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Fig. 24. Deodar *(Cedrus deodara)* at the Morris Arboretum.

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

## THE DEODAR

The true Cedars are among the noblest and most picturesque trees. There are four species in the genus *Cedrus,* differing in habit but only slightly on morphological grounds. Thus some authors consider them as geographical forms of the same species. However, as they occur in widely separated areas and are readily recognizable as distinct, it is preferable to regard them as species.

The Cedar of Lebanon, *Cedrus libani,* is the most famous of them all. This majestic tree is native to the ancient biblical land, and well known for its scriptural and historical associations. A photograph of this tree growing at the Arboretum appeared as the frontispiece of the July, 1939, number of the Morris Arboretum Bulletin (Vol. 2, No. 16). On the nearby island of Cyprus in the eastern Mediterranean is the little known Cyprus Cedar, *Cedrus brevifolia,* closely related to the Cedar of Lebanon and often regarded as a mere variety. In the Atlas Mountains in northern Africa grows the Atlas Cedar, *Cedrus atlantica,* a photograph of which formed the frontispiece of Vol. 2, No. 14, January, 1939. The fourth species, the Deodar, *Cedrus deodara,* occurs at high altitudes through the western Himalayas.

These majestic trees are widely grown as ornamentals. All species, except the Cyprus Cedar, are represented in the living collections of the Morris Arboretum by well developed specimens. Atlas Cedar is dependably hardy in the Philadelphia region, as is the Sargent strain of Lebanon Cedar. But only an occasional individual of Deodar survives. Of the Cyprus Cedar little is known in this area.

The Deodar is undoubtedly the most elegant and decorative of the true cedars. The tree is pyramidal in outline, especially when young. The branches and branchlets as well as the leader are drooping or strongly declined. It is thus easily distinguished from the other species, which have more or less erect leading shoots and stiff branchlets. The dark green needle-like leaves of the Deodar, averaging 1-1½ or sometimes to 2 inches in length, are also longer than those in the other species. These slender leaves together with the pendant branches give the tree a much more graceful appearance than the other species.

The tree is widely distributed throughout the western Himalayas from Afghanistan to Garhwal. It grows at 4,000-10,000 feet elevation, where it is the most important conifer. It thrives in various habitats but the best forests are found where the rainfall ranges from 40 to 70 inches. In its native habitat the tree grows up to 250

*(continued on page fifty-nine)*

# A REEXAMINATION OF PLANT LABEL PROBLEMS, WITH SOME NEW DESIGNS

J. R. Schramm

(Continued from page 43)

## II. LABELS NOT FOR ATTACHMENT TO TREE TRUNKS

### A. Hanging Label for Shrubs and Small Trees

In most collections of woody plants, especially if they contain much flowering material, shrubs predominate numerically. To the shrubs may well be added small trees, small either inherently or because of youth, since they present essentially the same problems in labeling. It is likely, therefore, that in most collections the label adopted for these classes of plants will require production in greatest numbers. In evolving the design described below, this fact has been kept in mind.

The assembly (Fig. 25) consists of two parts, the label proper and the hanging band, the material in both being highly rust-resistant stainless steel.

The label, of sheet steel 0.015" thick and 1½" wide, is embossed in 3/16" letters on a 5-line machine of the type commonly used for making conventional zinc labels. Details of fabrication will appear in the appendix. But here it may be pointed out that the label, already quite stiff by virtue of the thickness and temper of the metal, acquires considerable added stiffness as a result of embossing. This quality is highly desirable.

To ready the embossed label for hanging, it is provided at the mid-line with two punched slots near the upper and lower edges respectively. The hanging band is fashioned from a strip of sheet steel 3/4" wide and .005" thick. By folding over and flattening each margin of the strip (Fig. 26 at A) the original sharp sheared edges are eliminated, the new edges being velvety smooth. At the same time the band acquires considerable added resistance to lateral bending while retaining its ribbon-like pliability in the other direction.

*Hanging the Label.* — Attaching the label to the plant is depicted in Fig. 26, with a, b, and c successive preliminary stages in the process. The size of the hanging loop should be liberal to permit very free swinging of the label. This allows for growth of the branch. But it also permits gravity to keep the label horizontal at all times, making for easy reading and tidy appearance. Additional allowance is advisable if substantial growth and permanence is expected in the limb or branch to which the label is attached. In the latter case, provision can also be made (at the time of the initial hanging) for one later enlargement of the loop without resort to a new band. Additional band length can be provided by coiling the excess at the free end (at D in Fig. 26).

*Performance.* — The first installations at the Morris Arboretum were made 15 years ago, since which time the number has grown to many hundreds. Performance has been uniformly satisfactory, indeed excellent.

Aside from the permanence of the labels, being subject to no corrosion or other deterioration, the design has certain advantages which merit special comment.




Fig. 25. Design of hanging label for shrubs and small trees. For details see Fig. 26.

(a) *Visibility and Readability.* — The labels are bright — permanently so. At first it was feared that this might be objectionable. Actually it has proved advantageous. One of the minor exasperations of the otherwise rewarding experience of examining collections is the difficulty of finding and reading the labels, especially where embossed zinc, copper or other metals are used which darken by oxidation.

resulting in the death of the twig from that point outward. No injury has ever been detected under the hanging band, even when in full direct sunlight.

As already pointed out, all surfaces of the band coming in contact with the twig or branch are smooth. Though swinging freely, the subtending branch is never abraded. What little pressure the weight of the label exerts on the branch is widely distributed by the band. When wire is used this weight is concentrated along the narrow line where the wire rests on the branch, sometimes resulting in transverse grooving or other minor injury.

(b) *Horizontal Position.* — In almost all types of shrub labels the inscription is oriented vertically, the label being suspended from one end. In the present design suspension is effected by a metal band attached to the mid region with the result that the inscription is kept in horizontal position, thus facilitating reading.

(c) *Absence of Injury to Plants.* — The hanging band, being light in color, reflects much of the incident light. Consequently it does not heat up as does blackened (oxidized) copper wire. The latter in direct sunlight may get hot enough to kill the adjacent tissues, at times

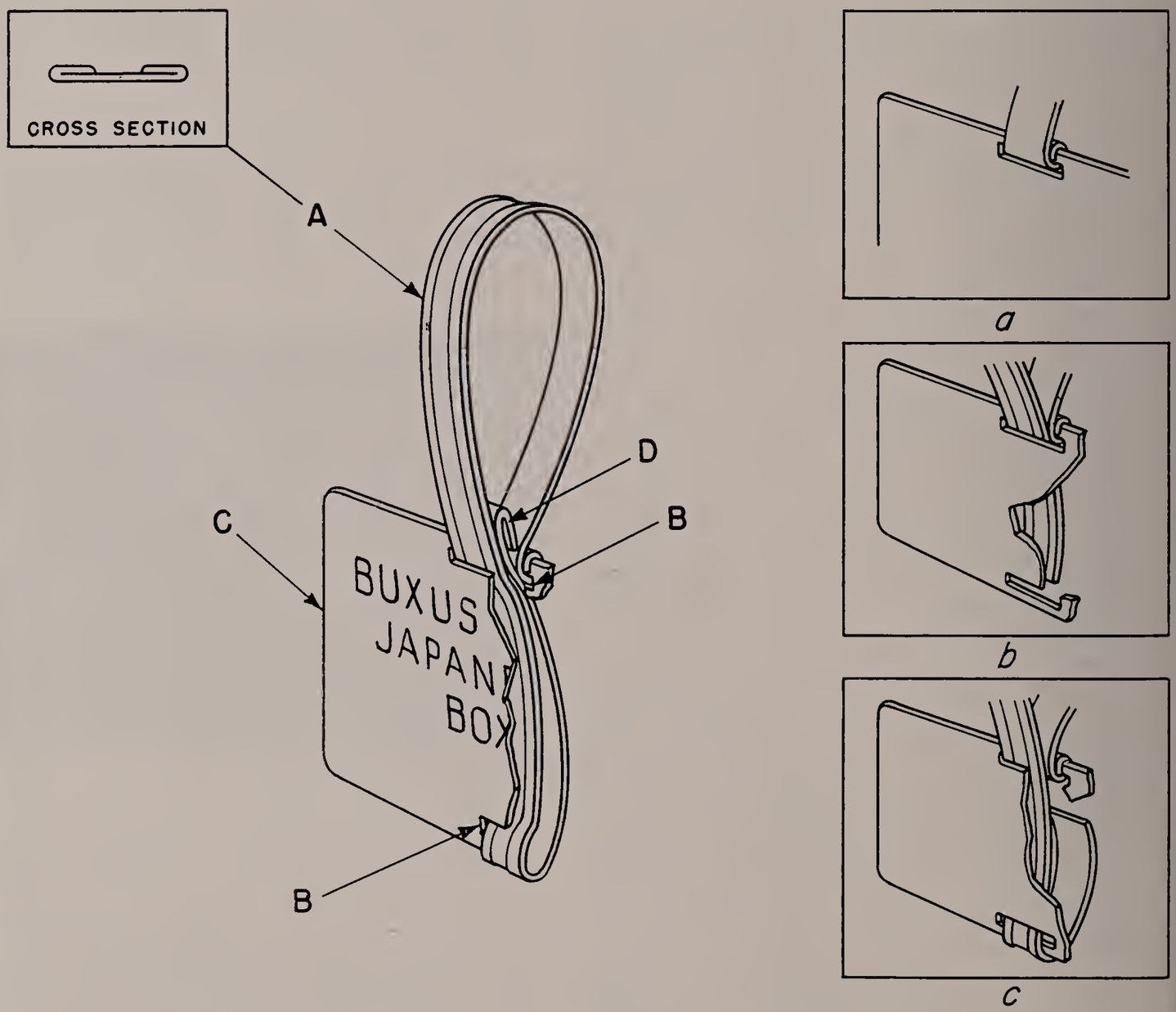



Fig. 26. Details of all-stainless steel label for shrubs and small trees.—C, embossed label, provided with punched slots at B and B through which is threaded hanging band A (shown at left in cross section). a, initial anchoring of band in upper slot; b and c, successive stages in threading the band through the slots and forming the hanging loop. End of band shown at D, where excess length is coiled if provision for future enlargement of loop is made at time of initial hanging.—*Drawing Courtesy of H. L. Yoh Company, Inc., Philadelphia, Pa.*

(d) *Susceptibility to Tampering.* — In the very nature of the case, shrub labels are within easy reach — of young and old alike. Removal by methods short of cutting the metal or severing the branch is much less easily accomplished in the present design than in labels with conventional twisted wire attachment. It is possible though difficult and laborious to unthread a hanging band without the aid of tools. That a few labels may thus have been mischievously removed at the Arboretum is, of course, possible; if so it has not come to our attention. But there is clear evidence that removal by twisting, apparently the source of more satisfaction, has been attempted. The stiff label gives the culprit a good grip. However, the band is so tough and so firmly anchored to the label that it does not give way. Here again some attempts may have been crowned with success, but if so we have not become aware of them. By reversing the twist the band, while kinked, is restored intact to full functional order. In all these cases the labels, put under considerable strain when used as the grip for twisting the band, emerged without mutilation.

(e) *Accession Numbering.* — It will be noted from Fig. 25 that the accession number of the plant to which the label is to be attached is not embossed on the label. Instead, the number is written on the reverse side in lead pencil. (As already noted (p. 42), a lead pencil record on the stainless steel is totally unaffected by weather.) By this procedure it is not necessary to preempt a line on the label for the accession number, in which the visiting public has no interest. Also, if through death or removal of the plant the label is freed, it can be reused on another plant of the same identity by merely erasing the former accession number and substituting the new, again in pencil. All labels temporarily out of circulation can, after removal of the bands, be filed alphabetically in card-index fashion, ready for reuse as occasion arises.* So handled, the labels are in fact perpetual. And putting the removed bands through a tinner's roller restores them to practically their original condition, and certainly to full usefulness. For all practical purposes the bands, too, are perpetual.

B. Removable Standard Label

The labels so far discussed require attachment to the plant. There remain some types of woody plants and certain situations in which attachment is either impractical or educationally ineffective, or both. Among these are ground cover plants (ivies, etc.); very dense and compact shrubs and small trees, notably certain conifers — including many dwarf forms; plants which are pruned back drastically every year, e. g., tea roses; etc. And in herbaceous plants, with which we are here not directly concerned, plant-attached label types are essentially useless.

In such situations recourse is inevitably to a standard inserted in the ground, to which the label is attached or of which it is an integral part. In view of the impressive number of standard labeling devices in use, many of them attractive and commercially available, proposing yet another will doubtless appear superfluous. If we nevertheless do so, it is because existing types lack one or two features which would be welcome if they could be incorporated in a practical way.

The brief general discussion of desirable features in labels appearing in the first installment of the present series (p. 36) is largely pertinent here. But aside from these, standard labels present certain special problems which merit comment.

(a) Unless firmly anchored in the ground, standard labels are notoriously vulnerable to removal and accidental or prankish interchanging. On the other hand, in certain situations anchoring in turn complicates maintenance (grass cutting, etc.).

(b) Standard labels are prone to become askew, leaning in this direction and that, and requiring frequent adjustment if collections are not to be marred by inebriate guides. How the standard is set in the ground rather than the type of label is usually responsible for this difficulty. However, if the standard is of metal and not sufficiently rigid, bending becomes an added factor. But even if the standard is rigid and so set that it effectively resists lateral displacement, there remains the necessity of anchoring, at least in collections at all exposed to mischief and vandalism. But anchoring, as already noted, in turn creates difficulties in certain situations.

It appears, then, that in addition to long life, acceptable appearance and educational effectiveness, immunity to leaning, secure anchoring, and easy and quick removability would be desirable features. As for removability, it is obvious, however, that the mechanism making this possible must be sufficiently cryptic to baffle those bent on mischief or worse. The following design represents an attempt to incorporate these more or less conflicting requirements in a standard label.

*Though the labels vary in length depending on the inscription, the width (1½") is uniform. The top of the label file is therefore even as in a conventional card file, and easily consulted. If the file becomes extensive, index tabs can be added to facilitate use.




Fig. 27. Design of removable standard label in position: left, in rose bed; center, among ground cover plants; right, in lawn. For details see Fig. 28.

Fig. 27 shows the label in position, with Fig. 28 depicting the assembly in some detail. Essentially the device consists of two parts: (a) an above-ground square standard with engraved label, both of black locust wood, fitted at its turned base into (b) an underground stainless steel tube which is so equipped that it becomes firmly anchored and braced as it is buried in the ground. These two parts are joined into a single assembly by an automatic locking device concealed beneath the ground level. By means of an appropriate key operated with precision from above ground, the locking mechanism is made to release the wood standard with its label. When grass cutting, repairs, or other operations are completed, the standard is reinserted in the buried tube, locking itself automatically.

Details of the device are given in Fig. 28 and its legend, and a discussion of fabrication will appear in the appendix. A few items, however, call for comment here.

It will be noted that the actual articulation of the removable standard and the tube buried in the ground is effected by the telescoping of two stainless steel tubes, with appropriate clearance. If the turned base of the wood standard (3 in Fig. 28) were inserted directly into the buried tube (5 in Fig. 28), the inevitable swelling of the former would result in binding, thus interfering with removal.

By providing the turned base with a stainless steel sleeve (4 in Fig. 28) the swelling is contained. Experimental tests with such assemblies submerged in water for weeks followed immediately by long freezing at low temperatures demonstrated that the tubular sleeve neither bursts nor is it perceptibly stretched or deformed

Fig. 28. Removable standard label: on left, "exploded" view showing details of design; on right, assembled unit in place, with releasing key in operating position.

1, black locust wood label block. 2, square locust wood standard with beveled top and turned base (3). 4, sleeve of stainless steel tubing fitting on turned base 3. 5, stainless steel tubing anchored and braced in soil and telescoping at its upper end on sleeve 4. 6 and 7, screw holes for fastening label block to beveled face of standard with stainless steel screws 8.

10, 11, and 12, the stainless steel locking mechanism consisting of a tube (10) in which are inserted in order the compression spring (11) and the plunger (12), the last seated in the spring. This locking assembly slides into hole 9 drilled through turned spindle 3. When sleeve 4 slides into position on spindle 3, the locking assembly is held in place by the outer shoulder of the plunger resting against inner face of sleeve 4 but with outer turned end of plunger projecting through and beyond hole 13 (drilled through only one side of sleeve 4). By depressing plunger projecting through hole 13, tube 5 telescopes onto sleeve 4, the plunger automatically engaging hole 14 when opposite it and locking the entire assembly into one unit.

16, locust wood block threaded on tube 5 and held in place at base of tube by rustless nail 18 inserted in hole 17 drilled through tube. 15, locust bracing block threaded on tube 5 and tamped into place just below locking plunger 12.

20, releasing key, with pins 21 engaging guide holes 19 in wood standard, thus automatically bringing releasing pin 22 directly opposite locking plunger 12. By slightly rocking top of key away from standard, the locking plunger is depressed, releasing the label. Sharp tip and edges of portion of key penetrating the soil insures easy operation of key. When reinserting label, plunger 12 is depressed manually to allow tube 5 to retelescope on sleeve 4. Locking is automatic when slight rotation of label brings locking plunger 12 opposite hole 14.

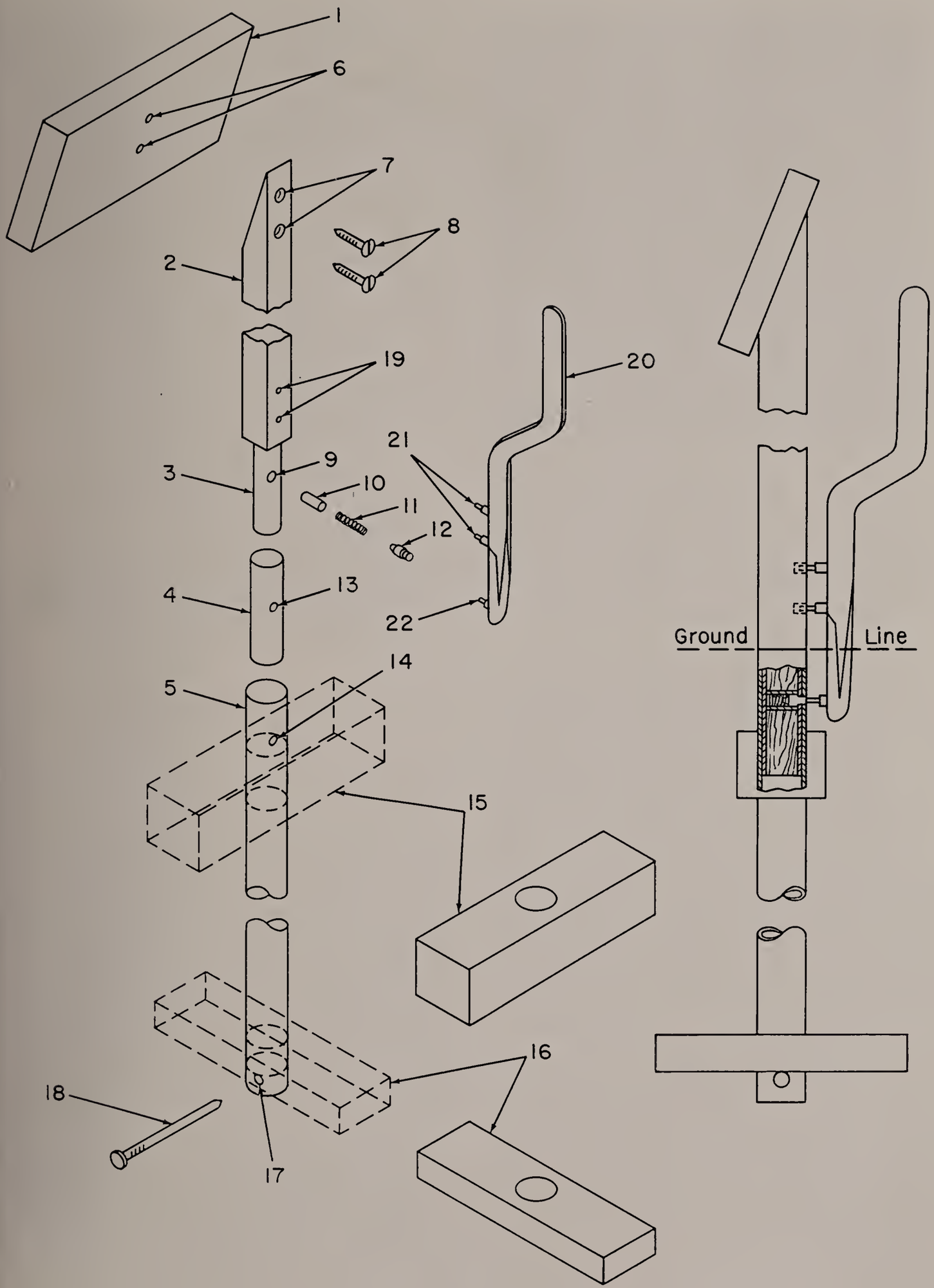



Fig. 28

by the combined forces of swelling and freezing.

In burying the soil tube, the lower block of black locust wood acts as the anchor, the soil being tamped around and above it. As the filling and tamping proceed, the upper (bracing) block is threaded on the tube at a level as high as possible to give maximum bracing without however interfering with the locking mechanism or operation of the releasing key. This bracing block presents a substantial surface to the soil on each of its sides and ends, — ample to prevent any movement of the tube in the soil by lateral pressure applied to the wood standard above ground. The entire assembly thus remains soberly vertical. If brute force is used on the standard, the latter will break at the soil line (where the turned base begins) rather than displace the underground complement. The anchoring block in turn thwarts any attempt to pull the entire device out of the ground.

*Interchangeability of Parts.* — All parts of the device are standardized and therefore interchangeable. All holes, both as to position and direction, are drilled on jigs. Assembled units are thus made up as needed from prefabricated standardized parts.

### C. Label For Greenhouse, Rock Garden, etc., Plants

In these categories of plants there appears still to be need for a label which is subject to no deterioration and is therefore permanent. For woody plants in the greenhouse on which plant-attached labels are practical, the all-stainless steel hanging label already described answers the requirements. But aside from these, some sort of standard label seems unavoidable.

The design (Fig. 29) here submitted was developed for the extensive collection of subtropical and tropical plants, mostly potted, in the greenhouses of the Department of Botany, University of Pennsylvania. Like the one for shrubs, the label is of stainless steel throughout. Similarly, the embossing of the inscription is done in the same way — with a 5-line machine on .015″ steel strips 1½″ wide. However, the maximum number of lines of embossed inscription is four. By centering the inscription on the strip, blank metal remains at the top and bottom which is provided with punched holes and then bent back at 90° angles so that the finished label takes the form of a very rigid channel. Through the four holes a preformed rectangular U of stainless steel rod is threaded from below, the two free ends being bent down where they emerge at the top of the label to form a two-pronged standard for insertion in the ground.

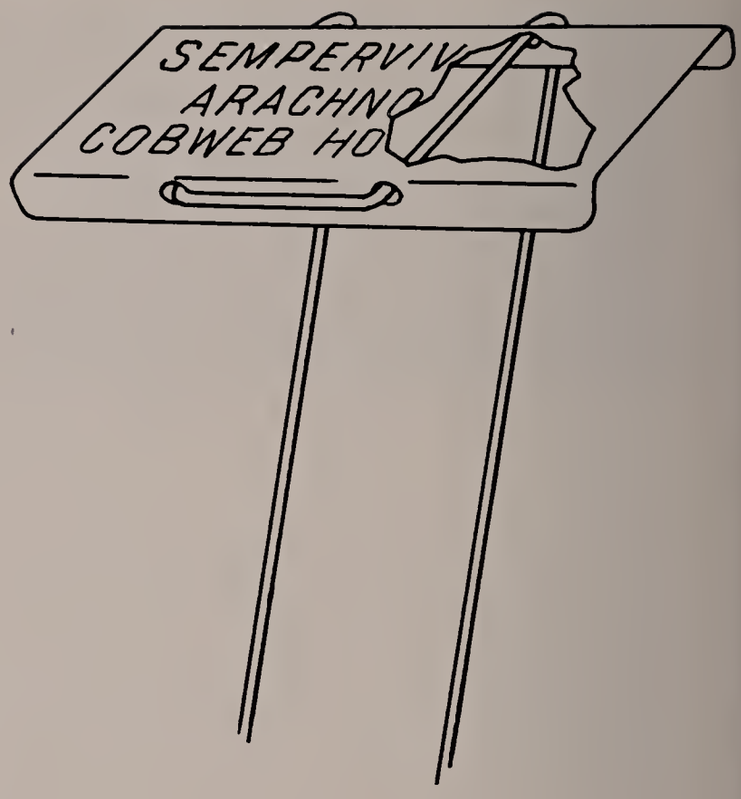



Fig. 29. Design of all-stainless steel standard label for potted plants, etc., with label tilted away from plant (for modification with label tilted toward plant, see Fig. 30).—*Drawing Courtesy of H. L. Yoh Company, Inc., Philadelphia, Pa.*

Several thousands of these labels have now been in use in greenhouses for 16 years, where they are subjected to especially severe test as regards corrosion. Not a single case of rusting or other deterioration has occurred. If the wire standards become badly bent or twisted, as has happened in a few cases either accidentally or by design, they can easily be replaced. But no instance of damage to the label itself has come to our attention. It may fairly be considered perpetual. If with year-in and year-out watering with city water the surface finally becomes dulled with mineral deposit, scouring powder restores it to its original condition almost instantly.

If the plants being labeled are carried under accession numbers, the latter are conveniently recorded in lead pencil on the back of the label. As already noted for the hanging label, such records on the stainless steel are completely

weatherproof, though easily removed with rubber eraser if the label is to be used on another plant with the same identity.

The design is such that the label is projected outward from the plant rather than toward it (Fig. 29). This makes for better visibility and readability, the label being less likely to be concealed by foliage; also, it interferes less with maintenance of potted plants. If for any reason it is desired to tilt the label in the opposite direction, this can be done very simply by threading the standard in the opposite direction, i. e., beginning at the top, with the bend in the prongs coming at the base of the label rather than at the top (Fig. 30).

Besides greenhouse plants, the labels are in use to some extent also out of doors — on rock garden, aquatic, and a few bedding plants. Wherever the standard needs to be longer, as in aquatics, a heavier, stiffer rod is used.

The uses of the present design — for potted plants, etc., — are such that it is not practical to anchor the standard in the ground. Consequently our label shares with previous designs the weakness that it is easily pulled out. An anchoring device could be added; but even if it were it would at best be a deterrent rather than a preventive. Those bent on mischief or worse would have no great difficulty in removing the labels. And in doing so the injury to the potted plant may be more serious than loss of the label.



Fig. 30. All stainless steel standard label for potted plants, etc., with label tilted toward plant. For details see Fig. 29.

*(The concluding Appendix, giving detailed information on materials and fabrication of the labels described, will appear in a later issue.)*

# THE MICHAUX QUERCETUM

This long range undertaking represents a joint effort of the Morris Arboretum of the University of Pennsylvania and the Northeastern Forest Experiment Station of the Forest Service, U. S. Department of Agriculture. It is financed in part by the Michaux Fund of the American Philosophical Society.

With the generous cooperation of many agencies and individual botanists and foresters, there will be established at the Morris Arboretum in Philadelphia a comprehensive living collection of all species and varieties of oaks adapted to the climate. The collection will constitute a memorial to François André Michaux, the noted French botanist and early student of American forest trees, notably oaks. On his death in 1855, Michaux bequeathed a fund to the American Philosophical Society, Held in Philadelphia for Promoting Useful Knowledge. By the terms of the bequest, the income is to be used for furthering the progress of forestry and agriculture in the United States. It is from this Fund that the Society is financing the present undertaking in part.

Every effort will be made to proceed in such manner that over the years the Quercetum will have the maximum practicable of usefulness in theorectical and applied research. More specifically, it will provide the materials and facilities for research on the following problems among others:

*Breeding* — The establishment of an authenticated collection of oak species (native and exotic) at the Morris Arboretum will provide the germ plasm for breeding, and particularly for extensive hybridization, with this most important hardwood genus.

*Taxonomy.* — The oaks are a very complex and taxonomically confused group. Approximately 80 species with some 20 varieties, and several hundred presumed natural hybrids, have been described from the United States alone. The studies outlined below should contribute substantially to delineating and establishing the validity of species.

*Progeny Tests.* — These tests will provide information on variation within oak species and some light on the existence and distribution of oak races.

*Tests of Exotic Species.* — The project will provide preliminary tests of exotic species from all temperate oak-inhabiting parts of the northern hemisphere.

## General Plan

The starting point in every case will be about 100 seeds each from individual wild trees geographically pin-pointed in wild natural stands, in every instance accompanied by herbarium specimens from the same tree whence came the acorns. The numerous presumed natural hybrids will be excluded, not because they are not interesting but because they would have less scientific usefulness while at the same time enlarging the undertaking to unmanageable proportions. Especially in species of wide distribution extending into diverse physiographic areas or climatic zones, separate seed and herbarium collections will be obtained from as many of these areas and zones as practicable. And in the same locality, collaborators are asked to make if possible separate collections from two trees. This will provide the minimum replication necessary to indicate the possible existence of races within the species.

The seedlings will be maintained in the seed bed for one year and in the nursery up to four years. During this time the progeny from each collection will be intensively studied, including critical attention to variability and any evidence of hybridity. Single-tree progenies showing significant variability or great deviation from the parental type, will be rejected and new seed obtained. Only from those single-tree seed lots which yield progenies true to type and not significantly variable* will a few individuals be transplanted when five years old to the permanent Quercetum. Every effort will be made to place the excess seedlings in collections which will likewise serve the above objectives.

The plants in the final Quercetum should thus represent an unusually authentic documented collection of oak species and germ plasm, available for research to all qualified investigators. More immediately, the seedling population studies will yield information and publications of value.

## Procedure

Active work began in the spring of 1953. In this first year of operation, efforts were confined to temperate North America in order both to get under way promptly and to gain experience. Many agencies and individual botanists and foresters have been invited to collaborate in the

*If all the seeds of any single-tree collection were first generation hybrids with a single male parent, the resulting plants would be expected also to be very uniform. This, however, is a remote possibility in a wild population.



Fig. 31. Rodent-proof oak seed beds in winter condition.

all important initial task of securing the necessary seeds and herbarium specimens in accordance with the procedures adopted. The response has been very generous.

By the end of the first season (1953), 29 botanists and personnel of the U. S. Forest Service had sent in a total of 150 separate seed collections representing 37 species and 23 states. Because of weevil infestation of acorns or the erratic or periodic fruiting pattern of numerous oak species, many additional collaborators were unable to make suitable collections in 1953. They will continue their efforts in subsequent seasons. At the conclusion of the present account are listed all who have already contributed material, together with some data on the collections.

To assist the collaborators in their work, each is furnished suggestions on collecting procedure and supplied with certain materials to facilitate collecting and forwarding. A list of these suggestions and materials is likewise appended.

From each individual seed lot received, about five acorns and cupules are removed, individually numbered in ink with the collection number, and filed in the herbarium. The herbarium specimen, taken by the collector from the same individual tree from which the acorns are collected, is likewise incorporated in the herbarium.

The remaining acorns, in most cases about 100 in number, are planted immediately upon receipt in specially constructed rodent-proof seed beds (Figs. 31, 32). To prevent the development of deep tap roots, the seed bed is underlain by flyscreen wire cloth 9 inches below the surface. This facilitates transplanting of the seedlings to the nursery and reduces losses.

During the year in the seedbed as well as subsequently in the nursery, the seedling populations, as already indicated, will be studied intensively. And by scheduling transfer to the nursery for the second spring, hardiness data will be secured while the populations are still in the seedbed.

In 1954 collecting in temperate North America will continue. At the same time activity will be extended to Europe, the Near East, and to certain parts of the temperate Orient. And in the years to come the area of collecting will be further enlarged as conditions permit.

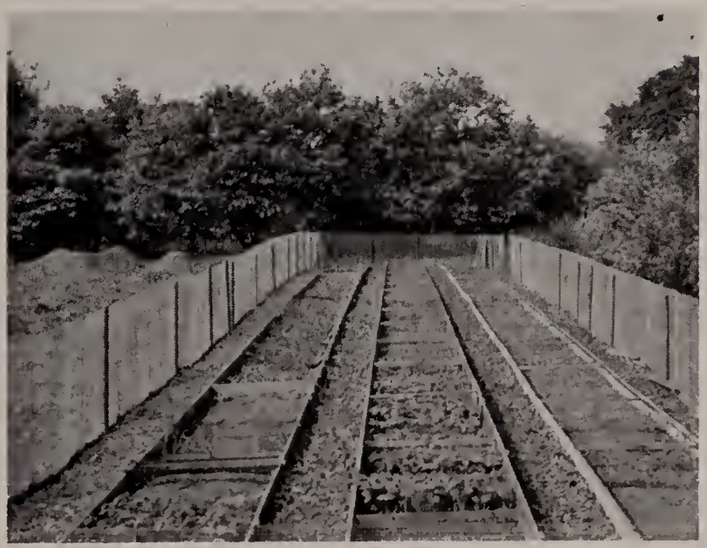


Fig. 32. Oak seed beds spring of 1954, showing seedlings. Hardware cloth (1/4" mesh) which in first winter serves as rodent-proof top, subsequently functions as rabbit-proof enclosure.

## Individuals and Institutions Contributing Collections in the 1953 Season*

Ahles, Harry E., University of Illinois
- *Q. alba,* Pulaski Co., Ill.
- *Q. bicolor,* Pulaski Co., Ill.
- *Q. borealis maxima,* Madison, Pope & Richland Co., Ill.
- *Q. falcata,* Williamson Co., Ill.
- *Q. imbricaria,* Madison Co., Ill.
- *Q. marilandica,* Pope Co., Ill.
- *Q. palustris,* Cumberland Co., Ill.
- *Q. shumardii,* Richland Co., Ill.
- *Q. stellata,* Cumberland Co., Ill.
- *Q. velutina,* Cumberland, Jefferson & Pulaski Co., Ill.

Anderson, D. A., Texas Forest Service
Collected by B. Zobel
- *Q. lyrata,* Houston Co., Tex.
- *Q. marilandica,* Harrison Co., Tex.

Collected by B. Zobel & R. Richard
- *Q. alba,* Montgomery Co., Tex.
- *Q. cinerea,* Houston Co., Tex.

Baldwin, Henry I., Fox State Forest, New Hampshire
- *Q. borealis,* Hillsborough Co., N. H.
- *Q. borealis maxima,* Hillsborough Co., N. H.

Baldwin, J. T. Jr., College of William and Mary
- *Q. spp.,* James City, Princess Anne, Warwick, Williamsburg, & York Co., Va.

Balls, E. K. (See under P. A. Munz.)
Bolton, R. T. (See under H. I. Baldwin.)
Everett, P. C. (See under P. A. Munz.)
Goddard, R. (See under D. A. Anderson.)
Gates, Frank C., Kansas State College
- *Q. borealis* or var. *maxima,* Pottawatomie & Riley Co., Kans.
- *Q. macrocarpa,* Pottawatomie & Riley Co., Kans.
- *Q. marilandica,* Pottawatomie Co., Kans.
- *Q. muhlenbergii,* Riley Co., Kans.
- *Q. prinoides,* Riley Co., Kans.

Hansen, H. P., Oregon State College
Collected by R. M. Marvin
- *Q. garryana,* Yakima Co., Oreg.

Hatmaker, Allen (See under E. G. Wiesehuegal.)
Hatmaker, J. T. (See under E. G. Wiesehuegal.)
Kriebel, Howard B., Ohio Agricultural Experiment Station
- *Q. imbricaria,* Wayne Co., Ohio
- *Q. palnstris,* Wayne Co., Ohio
- *Q. prinus,* Wayne Co., Ohio

Leeson, William M., West Virginia University
- *Q. ilicifolia,* Mineral Co., W. Va.

Marvin, R. M. (See under H. P. Hansen.)
Massey, A. B., Virginia Polytechnic Institute
- *Q. spp.,* Virginia

Morley, Thomas, University of Minnesota
- *Q. ellipsoidalis,* Dakota Co., Minn.
- *Q. velntina,* Goodhue Co., Minn.

Muller, C. H., University of California, Santa Barbara College
- *Q. agrifolia,* Santa Barbara Co., Calif.
- *Q. douglasii,* Santa Barbara Co., Calif.
- *Q. dumosa,* Santa Barbara Co., Calif.
- *Q. durata,* Santa Barbara Co., Calif.
- *Q. lobata,* Santa Barbara Co., Calif.

Munz, Philip A., Rancho Santa Ana Botanical Garden
Collected by E. K. Balls & P. C. Everett
- *Q. agrifolia,* Ventura Co., Calif.
- *Q. chrysolepis.* Shasta Co., Calif.
- *Q. douglasii,* San Luis Obispo Co., Calif.
- *Q. garryana,* Trinity Co., Calif.
- *Q. kelloggii,* Monterey Co., Calif.
- *Q. lobata,* Napa Co., Calif.
- *Q. wizlizenii ? frutescens,* Napa Co., Calif.

Olson, Jerry S., Connecticut Agricultural Experiment Station
- *Q. coccinea,* North Carolina

Richard, R. (See under D. A. Anderson.)
Shanks, Royal, University of Tennessee
- *Q. alba,* Knox Co., Tenn.
- *Q. borealis,* Haywood Co.. N. C.
- *Q. shumardii,* Knox Co., Tenn.
- *Q. shumardii schneckii,* Knox Co., Tenn.

Small, John A., New Jersey College for Women
- *Q. borealis,* Somerset Co., N. J.
- *Q. falcata,* Ocean Co., N. J.
- *Q. ilicifolia,* Ocean Co., N. J.
- *Q. marilandica,* Ocean Co., N. J.
- *Q. ilicifolia,* Ocean Co., N. J.

Taylor, C. A., South Dakota State College
- *Q. macrocarpa,* Brookings Co., S. Dak.

Tucker, J. M., University of California, Davis
- *Q. agrifolia,* Napa Co., Calif.
- *Q. dumosa,* Napa Co., Calif.
- *Q. durata,* Napa Co., Calif.
- *Q. wizlizenii,* Napa Co.. Calif.

U. S. Department of Agriculture, Forest Service
Central States Forest Experiment Station
Collected by L. S. Minckler & G. Deitschman
- *Q. borealis,* Hardin Co., Ill.
- *Q. coccinea,* Hardin Co., Ill.

Intermountain Forest & Range Experiment Station
Collected by W. J. McGinnis
- *Q. gambellii,* Sanpete Co., Utah

Lake States Forest Experiment Station
Collected by C. L. Arnold
- *Q. alba,* Cass Co., Mich.

Collected by R. N. Smith
- *Q. velntina,* Clinton Co., Mich.

Northeastern Forest Experiment Station
Collected by E. J. Schreiner & J. W. Wright
- *Q. borealis,* Delaware Co., Penn.

Pacific Northwest Forest & Range Experiment Station
Collected by G. L. Hayes
- *Q. kelloggii,* Josephine Co., Oreg.

Rocky Mountain Forest & Range Experiment Station
Collected by H. E. Brown
- *Q. gambellii,* Delta Co., Colo.

Collected by D. R. Cable
- *Q. gambellii,* Gila Co., Ariz.
- *Q. grisea,* Gila Co., Ariz.
- *Q. turbinella,* Gila Co., Ariz.

Southern Forest Experiment Station
Collected by J. S. McKnight
- *Q. lyrata,* Tallahatchie Co., Miss.
- *Q. nigra,* Washington Co., Miss.
- *Q. nuttallii,* Washington Co., Miss.
- *Q. phellos,* Tallahatchie Co., Miss.
- *Q. shumardii,* Tallahatchie Co., Miss.

Collected by R. Schoembe & J. Lewis
- *Q. coccinea,* Jefferson Co., Ala.

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*Because of weevil infestation of 1953 acorn crop in certain species or regions and absence of fruiting in others, many additional collaborators were unable to make suitable collections in 1953. They will continue their efforts in subsequent seasons.

*Q. falcata,* Ashley Co., Ark.
*Q. laurifolia,* Ashley Co., Ark.
*Q. lyrata,* Ashley Co., Ark.
*Q. marilandica,* Ashley Co., Ark.
*Q. nigra,* Ashley Co., Ark.
*Q. phellos,* Ashley Co., Ark.
*Q. stellata,* Ashley Co., Ark.

Collected by W. D. Smith
*Q. stellata,* Boone Co., Ark.

Collected by H. A. Yocom
*Q. coccinea,* Jefferson Co., Ark.
*Q. falcata,* Jefferson Co., Ark.
*Q. velutina,* Jefferson Co., Ark.

West, Erdman, Florida Agricultural Experiment Station
*Q. chapmanii.* Marion Co., Fla.
*Q. laurifolia,* Alachua Co., Fla.
*Q. myrtifolia,* Marion Co., Fla.
*Q. shumardii,* Alachua Co., Fla.
*Q. stellata,* Putnam Co.. Fla.
*Q. virginiana,* Alachua Co., Fla.

Wood, Carol Jr., University of North Carolina
*Q. velutina,* Orange Co., N. C.

Wiesehuegal, E. G., Tennessee Valley Authority
*Q. borealis,* Anderson Co., Tenn.

Collected by Allen Hatmaker & J. T. Hatmaker
*Q. stellata,* Bledsoe Co., Tenn.

Collected by J. T. Hatmaker
*Q. coccinea,* Anderson Co., Tenn.
*Q. stellata,* Bledsoe, Co., Tenn.
*Q. velutina,* Anderson Co., Tenn.

Zobel, B. (See under D. A. Anderson.)

## Suggestions for Collaborators

### A. Collecting Procedure

For each species or variety, collect:

I. *From a single wild tree in natural woodland*:
(a) 100-125 acorns as soon as ripe, and 6-12 cupules;
(b) a typical leafy branch (if possible with a few cupules attached) for use as an herbarium specimen.

It is basically important that all the acorns, cupules and the specimen *unquestionably come from the same individual tree.* Usually this can best be assured if the items are collected from a tree with low fruiting branches on the edge of a woodland.

Avoid trees which might possibly have been planted, also any which are suspected of being hybrid.

Reject acorns which show any sign of weevil infestation; acorns dropping early are often very heavily weeviled.

II. *From another tree in the same locality* make if possible a second collection exactly as outlined in I above, keeping it as an *entirely distinct and separately numbered collection from the first one.*

### B. Materials Furnished to Collaborators, and Mailing Procedure

For each collection (individual tree), the following are furnished:

1 polyethylene bag with sealer
1 self-addressed cloth bag
1 numbered stainless steel tree tag with copper nail
1 numbered collector's field label
2 numbered string paper tags

*All numbered articles for a single collection are in one envelope and bear the same number.*

Attach to the tree the tag with the enclosed copper nail; do not drive nail deeper than the cambium (to forestall overgrowing).

Attach one of the numbered string tags securely to the herbarium specimen.

Fill out the collector's field label; on the reverse side of the label, give if possible directions sufficiently precise to relocate the tree if this should prove desirable in the future.

Put the acorns, together with the second numbered string tag, into the polyethylene bag; seal the bag by twisting the sealer tightly.

Put the sealed polyethylene bag, *together with the filled out field label,* into the self-addressed cloth bag for *immediate mailing;* the seeds of some oaks lose viability quickly.

The herbarium specimen, after drying in an ordinary herbarium press, or under pressure between newspapers, can be mailed separately at a later date in the large self addressed envelope. In pressing, turn some leaves to show the underside.

Collaborators furnishing collections from more than one species in a season will find it convenient to mail all herbarium specimens at one time in the addressed envelope provided.

J. R. Schramm, *Director,*
Morris Arboretum of the University of Pennsylvania

Ernst J. Schreiner, *Forest Geneticist,*
Northeastern Forest Experiment Station,
U. S. Forest Service

# AKEBIA AS A WEED IN THE PHILADELPHIA AREA

H. L. Li

*Akebia* is a genus of long trailing woody vines native to eastern Asia. The leaves are long-petiolate and digitately compound (Fig.32), and are deciduous or half evergreen. Because of the slender growth and the graceful habit, as well as the elegant tender-green foliage, these vines are desirable ornamentals. In the spring they produce two kinds of dark purplish flowers, male and female, borne on the same raceme. The flowers are not conspicuous, but have a pleasing fragrance. The fruits, very large fleshy pods to nearly 8 cm. long, are at first green, later becoming purple; they are rarely produced in cultivation.

There are two species in the genus, *A. quinata* and *A. trifoliata,* both in cultivation. The first has five leaflets, the latter three. *A. quinata* is the more handsome and also is hardier. Both species are adapted for climbing on trellises or trees. Because of their slender stems they are more suitable for small modern houses and gardens than are the more familiar woody vines such as Wisteria and Trumpet-Creeper.

In their native haunts in China and Japan, these vines grow at low to medium altitudes in thickets and ravines and on mountain sides. While sometimes quite common, they never become exceedingly abundant.

Recently it was observed that *A. quinata* grows very luxuriantly at "Crosswicks," the former Clement B. Newbold estate at Jenkintown near Philadelphia which for a number of years has been reverting to an essentially wild state. Apparently originally planted, the species has spread vigorously. By 1953 it had covered an area of several acres, forming an almost pure stand in the form of a dense tangled mat covering the ground and overrunning all shrubbery and trees in its path. In the process it has choked out all herbaceous vegetation and killed many of the shrubs and trees it has overrun.

The vines flower freely and produce fruits in considerable quantity. Seedlings are abundant.



Fig. 33. *Akebia quinata* as an aggressive weed in the Philadelphia region.

The plant has apparently quite established itself and is able to spread aggressively under present conditions. On the grounds of the Pennsylvania School of Horticulture at Ambler near Philadelphia, Akebia, when not carefully controlled, also tends to spread as a weed.

It thus seems that *Akebia quinata,* left to itself, can become a serious pest in the Philadelphia region, reminiscent of Japanese Honey Suckle, *Lonicera japonica.* However, it will be much easier to control as the exceedingly large fruits are most conspicuous and easily removed. Moreover, there is no possibility of seed dispersal by birds, which in the honey suckle makes control so hopeless a problem.

## THE DEODAR

(*continued from page forty-six*)

feet in height. At old age it forms, like the other cedars, a flat, spreading top.

Deodar is the tenderest of all the well known true cedars. Aside from the one noted below, all specimens planted at the Morris Arboretum in the past, while surviving the milder winters, have perished in severe ones. The one exception appears as frontispiece (fig. 24). This stately individual, fully justifying the claim that Deodar is the most graceful of all conifers, was planted in 1937 as a seedling received from Mrs. Barnes from the University of Washington Arboretum. It has proved hardy through the years without the slightest sign of winter damage and now (May 21, 1954) measures 32.5 feet in height and 8.1 inches in diameter at breast height (12.3 inches near ground level), with a spread of the lower branches of 19.4 feet. It bears male cones in abundance but no female cones have yet been observed.

This individual tree obviously possesses superior hardiness for our climate. It is therefore being propagated vegetatively by grafting on Atlas Cedar seedlings as understock, the latter reliably hardy in this general region.

The cedars are admirably suited for growing as specimen trees on lawns, provided there is ample space for development. Their stateliness adds charm to any garden. They should be planted when not more than 4 - 6 feet high, and prefer a deep, loamy soil, well drained but moist.

H. L. Li

# Morris Arboretum Bulletin

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Volume 6 Number 1



*Rhododendron alabamense*

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

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# CHANGES IN THE STAFF OF THE ARBORETUM

On June 30, 1954, Dr. J. R. Schramm retired as Director of the Arboretum, after having served in that capacity for fifteen years.

John M. Fogg, Jr. succeeded Dr. Schramm as Director on July 1. Dr. Fogg holds the degrees of B.S. from the University of Pennsylvania and Ph.D. from Harvard, and has been a member of the University's Department of Botany since 1925. In 1941 he was appointed Dean of the College of Arts and Sciences, and from 1944 to 1953 he served as Vice Provost of the University.

Miss Janet L. Bowen was appointed Administrative Assistant of the Arboretum on July 1. Miss Bowen, a graduate of Swarthmore College, earned her Master's degree at the University of Pennsylvania and has served the University in a number of capacities before coming to the Arboretum.

Martha T. Lee (now Mrs. Ralph T. Starr) joined the staff as Propagator on July 1. Mrs. Starr, formerly a student at Vassar, had been a member of the Propagation Department of the Arnold Arboretum before taking up her duties here.

# IN SEARCH OF NATIVE AZALEAS

HENRY T. SKINNER[1]

The following notes are set down as an abbreviated record of a rather extensive collecting trip in search of native azaleas. Besides telling something of the journey and the plants encountered the following pages will also include information concerning the plant specimens collected on this trip so that a record will be available to others who may chance to study these specimens at a later date or who may wonder in what woods, on what mountaintop or along what stream a special azalea grows. But first an explanation.

Our native azaleas or "Bush Honeysuckles" were a source of admiration, frequently recorded, to the first European travellers on this continent. Several species found their way to Europe at an early date, were known to Linnaeus and were used in hybridization with the European Pontic Azalea* *(Rhododendron flavum)* and Oriental *Rhododendron molle* to produce the many-colored and very hardy Ghent hybrids which have graced our gardens for many years. But while a few species such as the Pinxterbloom *(R. nudiflorum),* Flame Azalea *(R. calendulaceum)* and Sweet Azalea *(R. arborescens)* have been cultivated to some extent in this country it seems strange indeed that until very recently no real attempts have been made either to select the better wildlings for garden cultivation or to use them as parental breeding stocks for the production of finer hybrids than the old Ghents. There are excellent potentials for a new race which might well offer strong competition to the "Japanese" azaleas with which our gardens are now filled. These native azaleas have a color range from white to pink, red and yellow, they may be dwarf or very tall, single stemmed or more stoloniferous than a raspberry bush — and certain of them root readily from cuttings. What other characters could be desired? Perhaps evergreen leaves, but this is not impossible to the breeder.

It was a realization of these facts, plus an awareness of the marked limitations of our present knowledge of the botany, genetics or even geographic distribution of the native species which led to the planning of a research project at the Morris Arboretum calculated to provide more accurate information about our native azaleas, their natures, their natural occurrences and their behaviour. A project with these objectives called for a study of the literature on azaleas, a detailed examination of herbarium materials assembled at various institutions and extensive study and collection in the field to determine more accurately the nature and distribution of the individuals comprising the taxonomic units as we now know them. The collection of many specimens at the same location provides data on variability which the single existing herbarium specimen cannot give, and this kind of information was essential for constructing a picture which may still require many years of examination and analysis to develop in its full clarity.

The project was initiated in 1950 in cooperation with the Department of Botany of the University of Pennsylvania and the Academy of Natural Sciences and was greatly advanced by a grant from the American Philosophical Society which made possible the field collecting trip of present concern and as undertaken by the writer during a leave of absence from regular duties at the Morris Arboretum. While this writer is indebted to many persons for assistance at all stages of this native azalea project, he is especially appreciative of the continuous guiding interest of Dr. W. H. Camp who was so largely responsible for the initiation of this venture, and to Dr. J. R. Schramm who, as Director of the Morris Arboretum, so effectively smoothed the way to make it possible.

## PREPARATIONS AND DEPARTURE

Plans for the collecting trip were laid early in 1951 and one of the first steps consisted of the preparation of a map of the eastern United States which could show by letter and color key the geographic distribution of wild azaleas likely to be in flower during each week from mid-March to mid-August, as discovered from numerous herbarium specimens previously studied. The canvas backing of this little map became very worn before the trip was over, for at every point this was the guide for direction of the next day's travel to catch azaleas in bloom. Then there was a large Rand-McNally atlas with location data for previously collected species. From a glance at this map one could tell where azaleas once grew, where collections had *not* been made and which points perhaps needed revisiting to clarify some question concerning the original collection.

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[1] Since 1952, Director, U.S. National Arboteum, Washington 25, D.C.

*"Azalea" is here used as the popular name for all deciduous or semi-evergreen members of the genus Rhododendron, in which genus they have been combined with the fully evergreen rhododendrons in current botanical practice.



Fig. 1. *R. canescens*

These, plus endless additional maps, were the guides. The equipment was interestingly diverse, consisting of piles of presses, blotters, newspapers and a specially designed electric drier for the pressed specimens; of digging tools, shears, burlap and packing materials for handling the living plants, of the inevitable cameras, labels, tags, and notebooks and of course one's personal living needs for a matter of at least a month or so at a time. For transportation the Arboretum had provided a Chevrolet delivery truck which was most happily selected for size, speed and rideability as was repeatedly proved during the succeeding 5 months of continuous travel over everything from first class roads to trackless hillsides, through the freezing spring floods of the Mississippi or through summer drought at 104 degrees. Into this truck were piled these many supplies in time for a mid-afternoon departure from Philadelphia on Saturday, March 17th. The goal was Florida, for the first azalea on the time schedule of our map.

The first run south provided the customary thrill of this rapid journey into springtime: from Pennsylvania winter to quinces and daffodils in Richmond; wisterias in bloom with the exotic azaleas of Charleston; and then in Georgia the potently delightful scent of the Jessamine thicket *(Gelsemium)* on the damp of the evening air. It is no wonder that this Jessamine is a southern favorite; it *is* a wonder that it is so seldom seen in Washington or Philadelphia where its Virginia representatives would almost certainly succeed.

## A FLORIDA START

The first azaleas or "Pink Honeysuckles" as a native of the South will always call them, were found with no little excitement along the edges of damp woods on the Florida side of the St. Marys River, along U.S. Route 1. They were plants whose flowers had deep pink tubes and pale to medium pink petals. The corolla tubes and often their supporting pedicel were covered with numerous little pin-head glands and the bud scales and unfolding leaves were hairy with a matted, silky pubescence. The only southern azalea with these several characters is *R. canescens,* the Florida Pinxter or Hoary Azalea and this indeed was it — as we (Chevvy and I) were destined to follow it for several weeks and over enormous distances. (Fig. 1)

At an appropriate spot, where azaleas were plentiful, my first "mass collection" of 25 or 30 flower-shoot specimens was made by random selection from as many different plants. Each specimen was recorded by number in a notebook; flower measurements were taken, flower colors, plant heights, location and growing conditions were recorded before the specimens were placed between newspapers of the collecting press. During the evening at some tourist court they would be rearranged before placement in the electric drier. Wherever possible, quantity collections of this sort were made at intervals of some 60 miles, with intervening "county collections" of a mere 5 to 8 specimens as more detailed indicators of distribution. A few run-of-the-mill small, living plants were taken at intervals for later study, just as were pieces, when detachable, of the unusual specimens with likely horticultural potentialities. Bundles of dried specimens or packages of accumulated plants were expressed to Philadelphia each week or so.

Quest of this early azalea led south as far as Putnam and Alachua Counties in the general vicinity of Gainesville, Florida, but apparently no farther. Just south of here the high dryness of Ocala National Forest was explored with considerable thoroughness but without return, other than in a still vivid experience of driving the truck down a steep sandy and rutted road to a crossing of the Oklawaho River, only to find that the bridge had been washed out in a previous storm. The only negotiable return lay by slow stages through undisturbed woodland with both darkness and the bottom of the gasoline tank staging a neck and neck approach. Ultimately a logging trail was discovered and the rest was of chief significance in teaching a lesson in preparedness which stood us in good stead on several later occasions.

At Gainesville I took the opportunity to check native azaleas in the herbarium of the University of Florida and also to spend several instructive hours with Dr. H. H. Hume in search of azaleas and hollies of the area before again following *R. canescens* northwest. Apparently skipping the coastal counties of Lafayette, Taylor, etc., it reappeared in fine quantity on the banks of the Suwannee River near White Springs, where on a warm day it was being worked by honey bees, bumble bees and butterflies. It reappeared very conspicuously with dogwood on crossing the Fall Line in Madison County and it became evident that southward occurrences in this region are only, in fact, in very localized pockets, often widely separated. Still travelling west, this azalea reached perhaps a peak in quantity on the banks of the Yellow River in Okaloosa County where bushes became small trees of 15 ft. or more with heavy, branching trunks. It reached a second peak across the Sabine River in east Texas where the flowers seemed somewhat larger, their tubes longer and the leaves less hairy than in Florida and Georgia. Pure white forms and deep purple-red ones, those with large flowers and small ones with yellow blotches or with delightful scent — all were found during the next six weeks which eventually revealed a distribution of this species from the South Carolina coast around the Gulf to the Trinity River in Texas and north across Arkansas and Mississippi to southern Tennessee and southern North Carolina. It clearly covers an enormous area whose only major gaps are the neutral soils of the Mississippi Valley, the Red Hills of Mississippi and Alabama and a few regions not generally suited to ericaceous plants.

## A Yellow Azalea

The first westward trip with *R. canescens* brought my introduction to the yellow Florida Azalea, *R. austrinum,* on March 26th near Geneva, Alabama, and in enormous quantity a few hours later along a woodland edge just south of the Florida-Alabama border. (Fig. 2) Apart from flower color, the general characters of this azalea are rather similar to those of *R. canescens* but it is more glandular. The little glistening red, pin-head glands cover pedicels and often vegetative shoots, as well as flower tubes. The flower may be wholly a clear, golden yellow or, more often, the petals may be yellow and tubes a variable strawberry red, giving one the impression that this red tube belongs more properly with *R. canescens* and has perhaps been acquired by *R. austrinum* after flowering at the same time along the same streamsides and producing a proportion of those unmistakably anemic buff-colored hybrids for many years past. As the banks



Fig. 2. *R. austrinum*

of the Yellow River grow luxuriant *R. canescens* so elsewhere they are appropriately covered with masses of the yellow "Florida" Azalea which was subsequently found to occupy a sizeable portion of western Florida, southeast Mississippi, southern Alabama, and southwest Georgia — about as much territory outside of Florida as in.

Later collections of *R. austrinum* were made on the return from Texas on a more northerly swing. Spring was advancing and *R. canescens* was in collecting condition as far east as Georgia's Altamaha River where it occurs in masses of rich pinks almost across from Old Fort Barrington and the former haunts of the long-lost *Franklinia.*

## And Some Variations

Several curiosities had shown up: we had seen pure white *canescens* but in southern Alabama there were whites and pale pinks with yellow blotches and with the lemon scent of *R. alabamense,* yet they could not be identified as this species. (Fig. 3) At one point a woodland glade was surrounded by a bizarre display in yellow, orange, white-pink, salmon and every intermediate color one might name. Several of these plants were sent back, earmarked as progeny from an apparent triple union between *R. canescens, austrinum,* and *alabamense.* On a quick return across central Georgia and Alabama a curious break in *R. canescens* was found on the hills of northwest Alabama and across into Mississippi in which the



Fig. 3. *R. alabamense* x *canescens*

flowers were somewhat smaller, of uniform color (lacking the red tube) and were often yellow blotched and scented. Through later collections, this variable assortment, typical of nothing in particular, was traced as far north as Cumberland County on Tennessee's Cumberland Plateau. Obviously they had points in common with the hybrid swarms above, but they are widespread, much older and almost certainly contain a dash of *R. nudiflorum* rather than the *austrinum* of the last mentioned mixture.

Rains had been heavy during the course of a too early search for *R. alabamense* (See Cover) proper and it was a mud covered Chevrolet that approached Atlanta, Georgia on the 20th of April to collect mail, replenish supplies and permit a brief pause for scheduled meetings with Jesse C. Nicholls, the azalea-conscious salamander purveyor of Murphy, North Carolina and with W. P. Lemmon of nearby Marietta, student of southern azaleas and authority for three recently described species.

### The Red Azalea of Georgia

A few miles southwest of Atlanta our attention was momentarily caught by a splash of brilliant orange in a woodlot not far from the road. Brakes were promptly applied and subsequent investigation revealed an assortment of plants, 2-3 ft. high, in oranges, orange-reds, salmons and strong pinks. Unlike our collections to this point, these flowers were distinct in being almost totally devoid of pin-head glands, just as the leaves seemed nearly hairless on their undersides. Only one Georgia azalea fits a description of this sort and that is "red-flowered" *R. speciosum,* the Oconee Azalea, which during the next day or so was pursued from here to north of Atlanta, across central Georgia to Augusta, and down the Savannah River to Clyo in the vicinity of its original place of discovery by Andre Michaux at Two Sisters Ferry. Not particular as to habitats in central Georgia, the Oconee Azalea is a rather confused species in this region. One can guess that it has been on too familiar terms with aggressive *R. canescens* for some time—with results becoming evident through individuals with large, salmon or strong pink flowers, with small red flowers with orange blotches or with variability in their possession of pin-head glands or leaf tomentum. Such variants thrive on level ground in warm, sunny places. On the Savannah River a more uniform Oconee Azalea remains an inhabitant of the fairly shady red clay bluffs of the west bank where specimens may be found in excellent deep Saturn red — a red of the Coastal Plain which is unlikely to fade under cultivation. At Two Sisters Ferry the present farm owner told me that he gave up the last ferry boat about thirty years ago. The old road to the river has long since grown up to brush but some aged orange-flowered specimens of *R. speciosum* still grow near the boat landing, just as Michaux saw and described them in 1787. This is a handsome azalea which has already become so scarce that protective measures might well be considered by those who love the wild plants of Georgia.

### By the Atlantic to Virginia

Descent of the Savannah River in search of the Oconee Azalea had also led by design towards Beaufort County, South Carolina, which lies across the river on the Atlantic coast, due east of Clyo; but to cross the river one must necessarily travel very nearly to Savannah itself, which happened to be convenient for dispatching plants and for procuring labels and other needed supplies. Beaufort County, South Carolina, is the "type



Fig. 4. *R. atlanticum*

locality" for the Coast Azalea, *R. atlanticum,* (Fig. 4) which according to our map should be in flower at the end of April. Our lead was correct for on April 27th the first plants were found in quantity not far from Burton where they held splendid pink blossoms knee high above fern and inkberry in the moist soils of cutover oak woodland. From this point, and with sundry detours, the Coast Azalea was followed in constant flower through the coastal counties of the Carolinas and Virginia and, with a week or two's break, to its most northerly distributional point on the Delmarva peninsula in Delaware. Here in Delaware it is still a low growing azalea; it is generally white flowered and often highly glandular with pin-head glands on leaves and shoots as well as on the flower parts; the leaves may be glaucous beneath. It would seem likely that such plants as these are most akin to the original form of this azalea and that the pink flowered and less glandular representatives of South Carolina and Virginia may imply a measure of genic interchange with pink flowered *R. canescens* and *nudiflorum* of these regions.

In late April and early May the Coast Azalea makes truly a splendid sight as a multihued understory to the open pine woods of the coastal Carolinas. Since it is highly stoloniferous it recovers promptly in the wake of the brush fire or roadside trimming or grazing so that the year following will again see hundreds of upright flower clusters on wiry, knee-high stems borne by one plant an acre or more in extent. A mass collection of separate clones may necessitate covering a considerable territory to be sure that the 25 or 30 specimens are indeed different.

The course from Savannah to Norfolk, Virginia in search of *R. atlanticum* sounds very direct as just described. It is a distance of 500 road miles which was actually logged on the speedometer at a little more than twice this amount or 1200 miles—which is a fair illustration of the difference between plant collecting and just driving from one point to another! In this particular case the more inland pink azaleas of the Piedmont, *R. canescens* and *nudiflorum,* were also in flower so that the interior counties of the Carolinas were covered in a fairly thorough fashion on a zig-zag route which hit back to the coast at intervals instead of merely following it.

These side excursions were productive of many specimens and several valuable pieces of information. In South Carolina they yielded material from hybrid swarms obviously involving both *R. canescens* and *atlanticum* which are interesting as an indication that a measure of gene exchange does occur between these species; also in South Carolina it was discovered that the inland red clay hills of the Piedmont, which lie roughly between Columbia and Greenville, support very few azaleas. These hills grow excellent red cedar and have a soil pH often in the vicinity of 7.0, which is doubtless the explanation; and finally, in southern North Carolina, was discovered the interesting area of geographic overlap between southern *R. canescens* and northern *nudiflorum* as represented by pink flowered azaleas whose morphology might well test the patience of any precise taxonomist (and as they doubtless have).

### A Virginia Transect

Saturday, May 5th, dawned a soft, spring day amid the attractions of Colonial Williamsburg; but it was an unusual tourist who departed as early as he had arrived late, having spent time to enjoy no more than a bed and a passing view of the Palace Green in his hurry to catch as many as possible of the "honeysuckles" now blooming from here to Alabama and the mid west.

Of immediate concern was a planned sampling of the Virginia population of *R. nudiflorum* as it extends from Chesapeake Bay and the habitat of *R. atlanticum* to the Blue Ridge and the mountain home of the northern Roseshell Azalea, *R. roseum.* Variation in the Pinxterbloom Azalea had already posed some questions upon which a transect sampling of this kind was expected to shed light. Mass collections of *R. nudiflorum* were made in Gloucester County at the mouth of the Chesapeake and were continued across the state at intervals of approximately forty miles to the base of the Blue Ridge near Sperryville. From this point collections were made at each 500 ft. increase in elevation to the top of Pinnacle Peak in the Shenandoah National Park, permission to make such collections in the National Parks and Forests of the East having been obtained during the planning stages of the expedition. One of the exciting finds was at the start of this run, not far from Gloucester, Va., where among some cut-back Pinxterblooms near the roadside was one with perhaps the most remarkable coloring I saw anywhere. It was a large blossom in an intense plum purple with strong yellow blotch. There was only one flower head which I cut for a specimen and after measuring, recording and pressing the collection I returned to dig the plant for horticultural use. But unhappily my "find" was already a loss for the small plant could nowhere be found in the heavy brush. Henceforth I learned to dig first and cut afterward — or mark the plant!

At the western end of this transect, azaleas were only just coming into flower at low elevations of the Blue Ridge on this first visit on May 7th. On a return on May 21st, similar azaleas were

collectible to two-thirds up the mountain. Completion of the transect at the highest elevations was not possible until June 2nd, or in other words an elevation increase of approximately 2400 ft. delayed flowering by almost a month.

By this time (May 8th) *R. alabamense,* an azalea on which more information is needed, was surely coming into flower in Alabama. This, therefore, was the direction chosen after a brief stop for packing and mailing a good batch of specimens. This time the route kept to the western edge of Virginia and the Carolinas to secure one more coverage of *R. nudiflorum* and *canescens* before striking into Georgia where the latter species was now just about over. A call was made at the University of Georgia in Athens before heading north via Gainesville to the mountains of Lumpkin County for a check on Flame Azalea in the vicinity of Neel Gap. Early *R. calendulaceum* was full out in clear yellows to deep orange in Vogel State Park; it was also seen in exceptionally large flowered specimens in a small ravine just north of Gainesville. One or two of these had such brilliantly red color that one instinctively thought of the Oconee Azalea growing not too far south — and wondered whether this red in Georgia *calendulaceum* might have a rather special significance.

Again heading Southwest, it was on May 12th that the first true *R. alabamense* was found in full flower on the same hilltop in Marshall County of North Central Alabama where they had been seen in tight bud almost a month earlier. It was a real thrill to find this beautiful little white azalea with its dainty, thin-tubed flowers, yellow blotched and deliciously lemon scented. In its "best" individuals this azalea of the Alabama hills is also low growing and quite stoloniferous, it bears foliage which is often glaucous beneath — and as glandular as that of white flowered, low growing and stoloniferous *R. atlanticum* of coastal Delaware.



Fig. 5. *R. canescens*

*R. alabamense* is obviously later flowering than *R. canescens* but the two have nevertheless hybridized to produce numerous intermediate individuals, intermediate in flowering time, often taller growing than the true Alabama Azalea and varying in color from pure or yellow-blotched white to pinks, often without the deep pink tube of *canescens* proper. As it is followed through Cullman and Winston Counties the Alabama Azalea is found very much on the fairly dry hilltops and often on the eastern slopes where it seems tolerant of considerably more shade than *R. canescens.* Still white flowered but taller growing and in less "pure" form, it leaves the wooded hilltops to flow down sunny slopes to the Sipsey River in a mantle of May snow, as far as the eye can see. In such places, though without such pronounced fragrance, this is unquestionably the clearest and showiest of all white native azaleas.

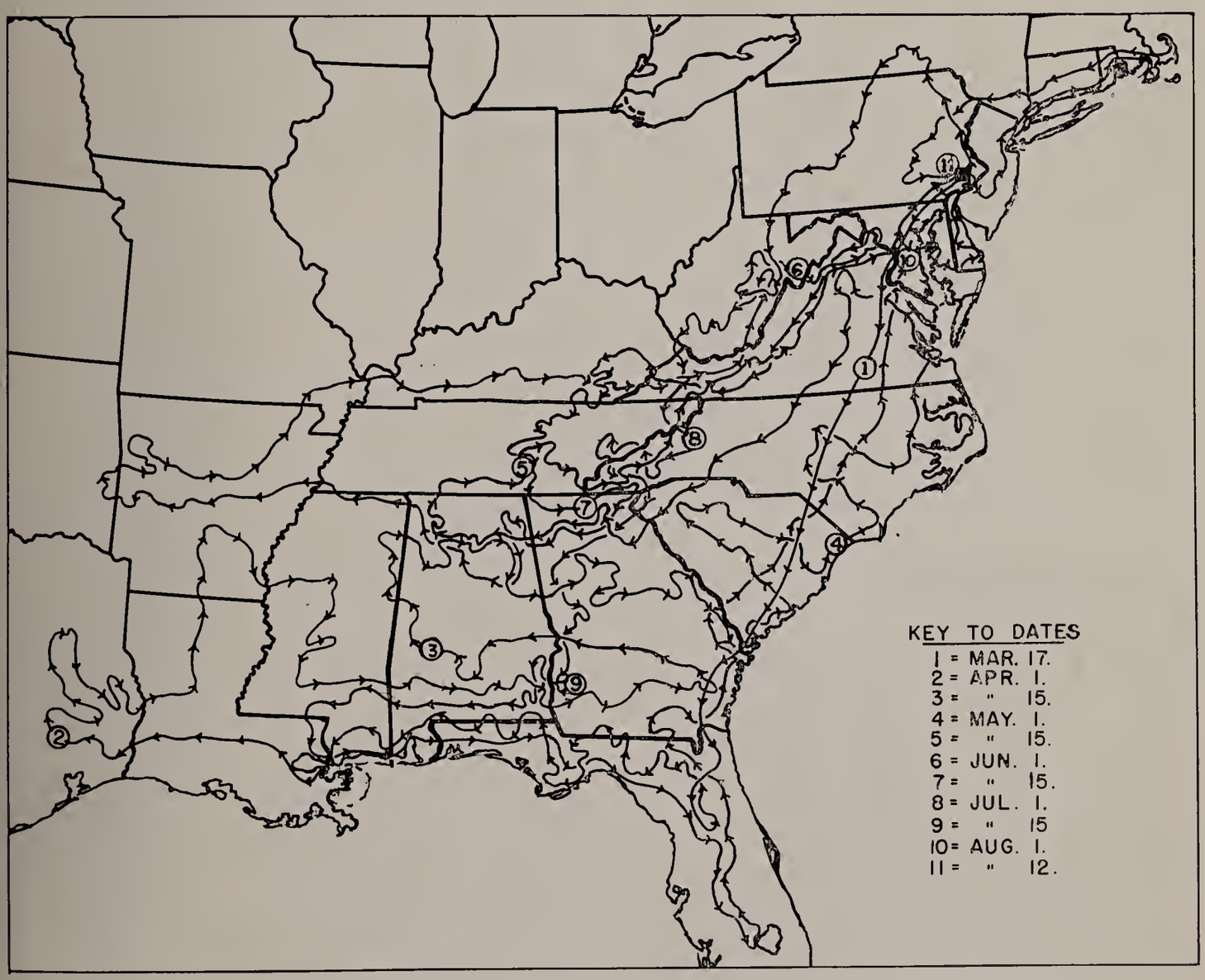
Much as one would have liked to linger in this intriguing collecting area, the azaleas of the north were now calling much too loudly — *calendulaceum, atlanticum* north of Virginia, *roseum* and *nudiflorum* in Pennsylvania and New York, and so on; and none of them would wait. But information was still needed on the early azaleas of Tennessee. A route was consequently taken due north across the Tennessee River in the vicinity of Mussel Shoals, then east through southern Tennessee to the rising escarpment of the Cumberland Plateau. Other hills of northern Alabama were covered with the confusing *R. canescens-alabamense* complex mentioned earlier but good *R. canescens* (Fig. 5) was again found in the occasional sphagnum bogs which are scattered across the red soil land of southern Tennessee. These red soils are interspersed with limestone outcrops, and produce abundant black locust and red cedar, but few azaleas, except in these upland bogs. If these boggy areas are followed northeast from Fayetteville towards McMinnville, Tennessee, their azalea populations undergo a hesitant transition from *R. canescens* towards *nudiflorum,* settling down as relatively "pure" *nudiflorum* in the lowlands of Cumberland County. But the picture is quite different if we proceed directly east from Fayetteville and ascend the escarpment of the Cumberland Plateau. From below Sewanee the lower limestone strata are overlain with sandstone and beyond this point azaleas are immediately abundant in a confused complex reminiscent of *R. canescens, nudiflorum* and *alabamense* — all thoroughly mixed together and varying in flower color from pure white to lavender, pale pink with pale tubes and pink with deep red tubes, many of the plants being highly stoloniferous.

On the plateau this complex again extends north for 70 miles or more to Cumberland County, just as we have already followed it across northern Alabama from Mississippi.

On the southern edge of the Crab Orchard Mountains in Cumberland County a small detour was taken to explore Grassy Cove, a limestone sink of such proportions that farms and a small village are found on the level fertile floor of the huge hole sunken many hundreds of feet below the present level of the plateau. It has its own meandering river which flows northwest to disappear into a gaping cavern, and then changes its direction beneath a mountain whose lowest pass is 1000 ft. above the cove floor. It eventually reappears as the Sequatchie River flowing south towards Chattanooga. This was but one of so many marvels of scenery whose exploration and enjoyment was a constantly fascinating accompaniment to this quest for azaleas.

From Grassy Cove the route lay down the scenic Sequatchie Valley with side excursions to the plateau ridges on either side. On the upper sandstones azaleas remained abundant but on the limestone valley floor they occur only along occasional streamsides amid sandstone boulders washed from the upper slopes. It was repeatedly observed that azaleas grow in limestone areas, often abundantly, but detailed observation invariably reveals a situation like the above or a restriction to leached hilltop soils a few inches or a few feet in thickness as they cap the limestone ridges of Virginia, Kentucky and Tennessee.

Leaving the Sequatchie Valley by striking east over the Walden Ridge the road descended into the Great Valley of the Tennessee River. It crossed the river and valley in a south-easterly direction and ascended the foothills of the southern Appalachian Mountains in the vicinity of the Cherokee National Forest. Apart from the appall-




Itinerary of the Trip

ing vegetational desolation resulting from copper smelting in the Copperhill-Ducktown region of Polk Co., Tennessee, the uplands of this southern mountain area present some of the finest scenery and most luxuriant forest cover discoverable in the East. Across into North Carolina the great National Forest of Nantahala is named for the Indians' "Land of the Noonday Sun." Here the valley sides are so steep that direct sunlight is soon lost, while an annual rainfall of over eighty inches is only matched on this continent in local areas of the Pacific Northwest. Within this forest an initial visit was made to the summit of 5400 ft. Wayoh Bald, native habitat of *R. arborescens* var *Richardsonii* as recognized by Rehder. But the mountain is populated by only late flowering azaleas, none of which were yet open. However, typical large flowered *R. calendulaceum* was found in full flower at lower altitudes on entering North Carolina and was thus followed to Asheville and well up into Virginia. A half day pause was made at Asheville and the Biltmore Estate to examine a part of Louis Shelton's diversified charge — the Beadle collection of native azaleas, which without question is the finest anywhere assembled. The visit was especially enjoyable in the instructive company of Sylvester Owens, who assisted in collecting the many hundreds of plants and in whose immediate understanding care they fortunately remain.

### The Virginia Mountains

Back in Virginia *R. roseum* and *nudiflorum* were still in flower and in the Jefferson National Forest on a hill slope near Konnarock a collection was made of an interesting group of triple hybrids involving these two species and *R. calendulaceum* — which would imply the somewhat puzzling combinations of two diploids and a tetraploid if published chromosome counts have actual application in the wild. The hybrid progeny included small, sweet scented pinks with yellow blotches all the way to salmon yellows of the same flower size as normal Flame Azalea.

Farther North a second especially interesting stop was at Peaks of Otter in the Blue Ridge where a transect was run down the west side of Broad Top Mountain. This transect took five hours to accomplish and was decided upon after brief analysis of intermediate elements of a continuous azalea cover which runs from elegant, highly glandular *R. roseum* on the mountain top through transitional stages of vari-colored, stoloniferous individuals to "good" *R. nudiflorum* at lower elevations conveniently reached by a gravel road sharply descending from the much-traveled Skyline Parkway.

Taking a somewhat westerly detour, the next main stopping point was a return visit to the Shenandoah National Park for further collections on the Pinnacle Peak transect after obtaining maps and much helpful advice from Park Naturalist Paul Favor. This was on May 21st and time was passing. With the last specimen tucked away — around 6 p.m. it seemed increasingly imperative to reach Delaware as soon as possible for a last collection of Coast Azaleas. The road lay via Washington and the Annapolis ferry, the new Bay Bridge being as yet under construction. With a pause for a joint gas tank and personal refueling in Washington the one hundred and twelve miles to Annapolis was completed still in time to find lodgings for the night.

Crossing the Chesapeake by ferry early next morning a search was begun for Choptank Mills, Delaware, this being a remembered collecting locality of Philadelphia's Witmer Stone in 1904. Exclusive of type localities this was one of the few occasions on which a former collecting site was deliberately sought, in this case to save time. But the opposite results were secured. Choptank Mills was not on the map; by telegraph inquiry it was unknown to the State Police of Delaware, Maryland or Virginia or even to the Postmistress of Choptank—after a lengthy drive to locate this tiny, unhurried village at the mouth of the Choptank River in Maryland. No Coast Azalea was seen and only one clue remained to investigate: the Choptank River did have a source in Delaware as a small stream in the vicinity of Sandtown. By this time we were driving the Atlantic side of the peninsula and a few azaleas had been located; at Sandtown, however, they suddenly appeared in such abundance in pure white to pale pink flowers for roadside miles that at least the ghost of Choptank Mills of 1904 must surely be nearby! Most of this was splendid dwarf, stoloniferous and highly glandular *R. atlanticum,* the kind of plant one could easily regard as a prototype of the rather confused *canescens*—friendly representatives of its South Carolina "type locality" — and a single plant of it would have been well worth the time and mileage of the search to find it.

Back to Philadelphia that evening and the enjoyment of three whole days of complete relaxation, only passingly devoted to checking specimens, restocking supplies and generally preparing for the last short haul of another nine or ten weeks in the field.

*(To be continued)*

# VISITOR FROM THE SOUTH

MARTHA H. STARR

Hurricanes "Carol" and "Edna" had left no doubt in the mind of anyone in the East that hurricanes were things to be avoided at all costs. By noon on Friday, October 15th, however, it began to look as if Philadelphia could no longer escape the 1954 wave of hurricanes which had been devastating the Atlantic seaboard. True to the weather bureau warnings, the wind and rain were increasing steadily by early afternoon. By four o'clock, trees and branches were beginning to crash to the ground. At five, we at the Arboretum left for home, having staked up all newly planted material and battened down the greenhouses as best we could. Two trees were down, but at this time we could not know whether this would prove to be the full extent of our damage or just the beginning.

The answer came Saturday morning when our superintendent John Tonkin took an early tour through the Arboretum. The winds which had reached their peak Friday evening had left scenes of devastation throughout the grounds. All the men who could be reached by telephone were called out to meet the emergency and, with axes and chain saws, began the prodigious task of clearing up the debris.

A subsequent survey revealed that, besides the many trees damaged by winds or falling branches, approximately fifty had been lost completely. These ranged in size from a three-foot lilac to a 120-foot tulip tree. Most had been uprooted, but a surprisingly large percentage had snapped off above ground level; due, at least in part, to the dry, hard-packed soil resulting from Philadelphia's summer drought. In these instances, the soil holding the roots firmly in place, the strain was taken by the trunk of the tree which then snapped. Very possibly, many younger trees might have been uprooted in a saturated soil, but they were saved by reason of its dryness. Unlike more mature trees, the trunks of the young were flexible enough to withstand the force of the wind. The small trees that did snap off proved to be already inherently weak.

We were extremely fortunate in losing such a small number of conifers. Aside from the grove of larches near the Administration Building, few conifers were blown down. The large Lace-bark Pine *(Pinus Bungeana)* beside the Rose Garden lost one of its four main trunks — and this is probably the Arboretum's greatest loss. However, the prized Himalayan Pine *(Pinus Griffithii)* and the Cedars lost hardly a branch, which was good news to all.

The Arboretum was also fortunate in the small number of Asiatic ornamentals lost. Although to our knowledge no accurate figures have ever been compiled, it is assumed by many that the Arboretum boasts more Asiatic trees and shrubs than natives (largely a result of Mr. Morris's great interest in Asiatic flora, an interest stimulated by his friendship with Mr. E. H. Wilson). If this assumption is correct, it is highly significant that fifty-five of the trees blown over or irreparably damaged were North American and European species, while only ten were Asiatic. The probable and interesting explanation of this lies in the fact that Eastern Asia is regularly subject to higher winds than is Europe or our own country, and these exotic species have over the centuries developed the deeper root systems necessary to withstand the gales. Conversely, it has proved impractical in many areas of the Asian coast to introduce American species because of their inability to cope with the unaccustomed winds. Dr. Li, who is well acquainted with the island of Formosa, reports that for this reason, repeated attempts to establish introduced species on the island have met with little success.

This relatively slight loss of our valuable Asiatics and conifers explains the general feeling at the Arboretum that after all we did not fare too badly from our bout with Hurricane "Hazel." Aside from the damaged *Pinus Bungeana* and two specimens of *Rhamnus crenata* sown from seed brought back from the Orient by Wilson, nothing was lost that cannot in time be easily replaced. The large Sophora and Ginkgo on the Big Hill, the neighboring Beeches, the Cercidiphyllum in the Japanese Garden, the Phellodendrons and Evodias all escaped with a minimum of injury. For that we can be truly thankful.

## ANALYSIS OF HURRICANE DAMAGE

| Trees uprooted | Height | Diameter |
|---|---|---|
| Cornus alternifolia | — | — |
| Cotinus americanus | — | — |
| Elaeagnus multiflora | — | — |
| Fraxinus pennsylvanica | — | — |
| Koelreuteria paniculata | — | 16" |
| Larix laricina | 56' | 16.5" |
| Larix laricina | 51' | 15" |
| Magnolia acuminata | 54' | 11" |
| Magnolia tripetala | 41' | 8.2" |
| Malus pumila | — | — |
| Malus sp. | — | — |

| Trees uprooted | Height | Diameter |
|---|---|---|
| Malus sp. | — | — |
| Malus sp. | — | — |
| Malus sp. | — | — |
| Morus alba | 27' | 15.2" |
| Oxydendrum arboreum | 41' | 7.8" |
| Prunus serotina | 75' | 26" |
| Quercus velutina | 80' | 26" |
| Quercus velutina | 75' | 26" |
| Rhamnus crenata | 33' | 26" |
| Rhus verniciflua | 42" | 10.1" |
| Robinia pseudoacacia | — | — |
| Tsuga canadensis | 56' | 20.5" |

Trees snapped off above ground level

| | | |
|---|---|---|
| Acer Negundo | — | — |
| Acer rubrum | — | — |
| Crataegus sp. | — | — |
| Eucommia ulmoides | — | — |
| Fagus sylvatica | — | — |
| Juglans nigra | — | — |
| Koelreuteria paniculata | — | — |
| Larix laricina | — | — |
| Larix laricina | — | — |
| Liriodendron tulipifera | 121' | 48.8" |
| Prunus cerasus | — | — |
| Prunus serotina | — | — |
| Prunus serotina | — | — |
| Prunus sp. | 60' | 9" |
| Quercus borealis | — | — |
| Quercus prinus | 80' | 25.5" |
| Robinia hispida "Monument" | — | — |
| Syringa vulgaris var. | — | — |

Trees damaged so severely as to necessitate their removal.

Acer rubrum
*Chamaecyparis obtusa Crippsii
Cladrastis lutea
Euonymus latifolia
Forsythia suspensa var.
*Ligustrum vulgare
*Magnolia obovata
*Magnolia tripetala
Ptelea trifoliata
*Rhamnus crenata
*Syringa amurensis japonica
(*Indicates specimens crushed by falling trees or limbs)

Trees so damaged as to impair their landscape value.

Acer Negundo
Acer palmatum
Acer saccharum
Carya cordiformis
Catalpa bignonioides
Halesia diptera
Halesia monticola rosea
Magnolia liliflora nigra
Nyssa sylvatica
Nyssa sylvatica
Nyssa sylvatica
Pinus Bungeana
Prunus serotina
Quercus prinus
Taxodium distichum

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*Azalea Meadow at the Arboretum*

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

## ARBORETUM ACTIVITIES

J. M. F., Jr.

*Beginning with this issue and under the above title we are initiating a series of occasional reports devoted to work accomplished or in progress at the Arboretum. Here, also, will be announced special events of interest to the public, such as the height of the Azalea season, which should be about the middle of May.*

Work on a number of important undertakings at the Arboretum has been seriously handicapped by the hurricane of October 15, 1954, which left in its wake a toll of uprooted trees and broken branches. The exact extent of hurricane damage was discussed in the preceding issue of the Bulletin (Vol. 6, No. 1), and it need only be added here that a major portion of the efforts of our small staff has, for the past five months, been devoted to the cutting up and removal of fallen trunks and limbs and the repairing of injured trees and shrubs. This prodigious task is now essentially accomplished and it is again possible to turn our attention to a number of projects, the completion of which will, it is hoped, considerably enhance the beauty and usefulness of the Arboretum. A few of these are enumerated here; others will be described in future issues of the Bulletin.

### Planting Plans

Since there are several large areas within the Arboretum on which permanent plantings have never been established, an intensive study is now being made of a planting plan which will make possible the development of interesting and attractive plant groupings in suitable locations. It is our feeling that, with certain exceptions, an attempt should be made to bring together as many species and varieties of a genus as can be reasonably assembled in a single area. This does not mean that fine specimens of such groups as *Taxus, Buxus, Ilex, Cornus, Viburnum* and *Lonicera* will not be found scattered throughout the grounds. Indeed, many such specimens or groupings of them already exist and there is no intention of disturbing them. However, since many visitors

*(Continued on page 23)*

# IN SEARCH OF NATIVE AZALEAS

HENRY T. SKINNER

*(Continued from page 10)*

### NEW YORK AND WESTWARD

A check of the flowering guide at this stage indicated the need for northern samples of the early species and for more westerly collections of both these and *R. calendulaceum*. Accordingly on May 26th a route was chosen via the Pocono Mountain area of northern Pennsylvania to the Finger Lake region of central New York for Pinxterbloom and Rose Shell Azaleas — or for what passes as these two species after their too rapid or too sociable post-glacial trek to the Carolina Hills of Ithaca. They were here in abundant bloom, in excellent color and in oft-proved hardiness but both species are a little more like one another than are *R. roseum* and *nudiflorum* of Virginia—a fact which has worried both botanist and azalea growers of the north on more than one occasion. Good collections of New York State Pinkshell were also made in the entertaining company of Dr. C. G. (Rhododendron) Bowers in the hills above Binghamton.

Travelling southwest into Pennsylvania the same azaleas were now getting past bloom except for some very showy specimens of *R. nudiflorum* in the high and late-season plateau area of Somerset County, Pennsylvania. On further into West Virginia *R. roseum* and *nudiflorum* were in flower at higher elevations and in the region south of Morgantown and Elkins *R. calendulaceum* was abundant in the early, large flowered form in shades of yellow to deep orange. Recognizing a possibly parallel situation to that in certain of the native blueberries Dr. W. H. Camp had earlier suggested that orange *R. calendulaceum* in this evidently tetraploid early flowering phase may quite logically represent a species originally derived from early hybridization between diploid red and yellow progenitors. Towards furnishing proof for this hypothesis an evident need was the field discovery of such suitable red and yellow diploid azaleas, if they should still be in existence. The Oconee Azalea is a red with suitable characters except perhaps, its time of flowering, and at this stage of collecting it was hoped that a small-flowered, fairly late, clear yellow azalea might perchance be found on some secluded slope of these westerly hills of the Virginias, Kentucky or in the Ozarks. Anticipating our story we can say that a late flowering diploid yellow was never found, and probably never existed but the diligent though fruitless search for it covered many square miles of territory and was always interesting. A number of unusual yellows actually turned up in West Virginia, in Kentucky, Georgia and Tennessee but always they were solitary plants and usually the product of hybridization between a late phase of *R. calendulaceum* and either *R. arborescens* or *viscosum*.

### HYBRIDS

One of the very interesting hybrid swarms was found on June 14 on the eastern slope of Spruce Knob Mountain in West Virginia. The plants were scattered through an abandoned pasture in a region where *R. calendulaceum, nudiflorum* and *roseum* all grew and bloomed together. The progeny of these triple matings were bizarre in the extreme — short and tall bushes bearing large or small flowers in every color from coral pink through salmons to rich lavender, pale yellow or pure white. The last was large flowered and otherwise identical with the Flame Azalea. Such happenings, exciting to the horticulturist, could obviously be most confusing when unexpectedly encountered in an herbarium where such specimens customarily lack any reference to flower color or to peculiarities of their occurrence. White-flowered hybrid progeny seem relatively frequent when parental *R. nudiflorum* is involved. (Fig. 6)

Returning to Virginia, final collections were made from the highest elevations of the Pinnacle Mountain transect before again striking southwest for later investigation of the more southern species. A later flowering and somewhat redder



Fig. 6. *R. calendulaceum nudiflorum*

phase of Flame Azalea was found in partially open bud on White Top Mountain and High Nob in southwest Virginia, at a time when the last blossoms of the normal large and orange-flowered *R. calendulaceum* were scattered on the lower slopes. This same joint occurrence was likewise met on June 6th on Big Black Mountain in Kentucky, only here at the higher elevation of over 4100 ft. the later "Camp's Red" phase of the summit would obviously not be at its best for another two weeks or more.

### In Quest of *R. cumberlandense*

Planning a return to the interesting azaleas of Black Mountain, we headed northwest for a general Kentucky reconnaissance in an eleven county circular swing to Yahoo Ridge, type locality for *R. cumberlandense* at the Kentucky end of the Cumberland Plateau.

Within a few miles the first little red and red-orange flowered azalea plants were found on a ridge of Pine Mountain in Letcher County, an azalea which in "best" forms makes a low, twiggy bush, often quite stoloniferous, with glossy green leaves often glaucous beneath and which may or more probably may not be quite the same as the late azalea of Black Mountain. At least on Pine Mountain this is undoubtedly *R. cumberlandense* of E. L. Braun's description and its smaller, thin-tubed flowers are immediately suggestive of a diploid if the earlier, coarsely large-flowered Flame Azalea is truly tetraploid — a point to be tested by later cytological examination of living plants collected for this purpose.

Leaving Pine Mountain there was an interval of several miles in which only normal *R. calendulaceum,* past bloom, was seen, but again at higher elevation in Owsley County beautiful little geranium-red azaleas were in shining bloom on a rocky cliff face; they remained with us in Clay County in Laurel County and in fact seemed quite common throughout these wooded hills of southeast Kentucky, all the way to Yahoo Ridge where the type locality for *R. cumberlandense* was revisited with the aid of detailed directions kindly furnished by Dr. Braun. Unfortunately the station where Braun had collected some time after logging operations in 1935 was now so rapidly reforesting that the shade was becoming heavy and the azaleas poor — a rotation which was frequently observed on this journey. Again and again the most striking displays of azaleas were in open woodland which had obviously been logged, cleared or burnt a few years previously. Presumably it is the scattered parent plants which burst into bloom with the sudden sunlight, set abundant seed and populate the forest floor before young trees again almost shade them out. In the long view one gains the impression of ephemeral, constantly shifting populations, except perhaps in the case of conservative *R. prunifolium* of West Georgia or *R. speciosum* of the Savannah River. By the average plant age the latter species seem to have occupied the same territory for many years. They reproduce sparingly.

As noted in this region perhaps the finest single Kentucky collecting point for the Cumberland Azalea was on a fire tower hill in west central Knox County. The road up this hill was one of those eroded rock and mud affairs which may have been passable to a jeep in good weather but which caused the Chevrolet to rest quietly near the main highway during an attack on foot. The hill was covered with open deciduous forest and towards the top, flowing over the ridges and down the sides of steep gullies was a multicolored riot of azaleas. It must have been a fairly old growth for while some of the flat-topped bushes were only waist-high others were well above eye level, indicating that fair height is attained by this species, at least in partial shade. Under these conditions, and compared with normal Flame Azalea, the flowers seemed especially thin-tubed and delicate and with a color luminosity, in the filtered sunlight, which the other wholly lacks. The shades of color were infinitely and widely variable from pale straw yellow through yellow-orange to red, and from salmon through pink to translucent cerise as lively as shot silk. Such diversity was often later found, although a constant leaning toward orange-red and red suggests that the latter may possibly have been the original color of this azalea.

Having confirmed the Kentucky occurrence of this distinct phase of former *R. calendulaceum* the next obvious task was to determine with some accuracy the limits of its distribution. So far it had been confined to the northern heights of the dissected west escarpment of the Cumberland Plateau so that a logical course was to follow this westerly escarpment southward — and the decision proved



Fig. 7. *Valley of the Sequatchie River*

a wise one. Leaving Kentucky on the 9th of June, this same little azalea was followed in comparative abundance into the upland woods of Scott County, Tennessee, into Fentress County, Overton County, Van Buren County, Sequatchie County, both west of the Sequatchie Valley (Fig. 7) and to the east on Signal Mountain. From here we were headed for Georgia — and the azalea was there too on Fort Mountain in Murray County. Continuing at about 3000 ft. elevation (in contrast to early *R. calendulaceum* of the lower mountain slopes) it was found towards the summit of Mt. Oglethorpe in Pickens County, and on Branch Mountain in Dawson County. It was on this mountain that a spot of brilliant red, like a scarlet tail-light, shone from the top of a cliff bordering the new highway 136. This little beacon was too fascinating to pass up, even though the only approach lay by way of a long flanking climb. But the reward was a tiny, twiggy, rock-clinging azalea plant 6 inches high, a foot across, gray leaved and covered like a pin cushion with its little red bells — as extreme a form of this *R. cumberlandense* as one could hope to find and a gem for the garden if its habitat is not unduly altered by cultivation. (Fig. 8) Traveling northeast into adjacent Lumpkin County the azalea stays with us near Woody Gap. In Union County it is especially abundant on the mountain slopes above Lake Winnfield Scott and not far away, just east of Wolfpen Gap in Vogel State Park, it covers a hillside in a billowy patchwork of clear yellow, orange, orange-red, cerise and all shades of salmony pink to apricot — both colors and plants so reminiscent of those of our fire tower hill in Kentucky that even before making a detailed check of less obvious characters one could scarcely doubt that this was the same Kentucky azalea. But was it? This particular spot happened to have been sought out by design for it is the type locality of *R. Bakeri* described by Lemmon and McKay in 1937, four years before *R. cumberlandense* was named by Braun from Yahoo Ridge. Since both descriptions fit these plants with reasonable accuracy it would seem that this gay little bush of the Cumberland Plateau must soon shed its dual personality to be recognized by the single, prior, though less happily descriptive name of *R. Bakeri*. Here in Georgia its color may tend slightly more toward the yellow and yellow-orange and its flowers may be slightly larger than when it was seen in Kentucky but such differences would seem to be of very minor consequence.

### Confusion in Macon County

Still anxious to find where else this little late red azalea might be, another visit was next paid to the Nantahala region of North Carolina, a few



Fig. 8. *R. Bakeri in northern Georgia*

miles across the Georgia border. The first plants were found in a deep valley on the approach to Wayah Bald from the west. The plants were 2 ft. high in stoloniferous patches deep red in color and just coming into bloom at this higher elevation. But they were not alone. On all sides were bushes in a bewildering array of colors, of heights to fifteen feet or more and of flower sizes to 6 centimeters across the "wing" petals. Either *R. Bakeri* had gone crazy or it had met up with something else. The latter seems probably the better guess, for not far away were a few late-flowering individuals of normal, early Flame Azalea. The sampling and collecting of this amazing population consumed a full half day during which time the characteristics of these intermediates became reasonably familiar. Finally heading to Nantahala Lake and Wayah Bald, imagine our astonishment at discovering that the fast opening azalea display around the lake and well up the slopes of the mountain was composed not of *R. Bakeri* or "normal" *calendulaceum* but entirely of recurring batches of these vari-colored intermediates which eventually settled down to something resembling a reasonably uniform "type" of their own.* Other collections were made on later visits to this region, and many more in principally orange and orange-red colors were subsequently found at higher elevations (above 3000 ft.) north through the mountains and right back again to southwest Virginia and Kentucky. A seeming third phase of the *R. calendulaceum* complex presents a puzzling pattern which will need much further study for elucidation of its true nature and origin; but the fact of its existence begins to shed light on the confusing flowering-time behavior of *R. calendulaceum* from different collection sources.

## And into Alabama

Having followed the Cumberland Azalea to Georgia and North Carolina there remained the possibility that it might also occur in Alabama — since the Cumberland Plateau enters into the northeastern part of this state. On the eighteenth of June the Chevrolet was consequently headed towards Jackson County, Alabama. Along the way some excellent Sweet Azalea, *R. arborescens,* was found in full flower, white with pale yellow blotch, growing with Catawba Rhododendron in a moist valley near Cloudland in DeKalb County and again not far away, while after crossing the Tennessee River and making a sharp climb of the steep ascent of the plateau north from Scottsboro in Jackson County abundant Cumberland Azalea was still in flower in open forest near Kyles on Crow Mountain. It was certainly in northern Alabama and on reflecting the matter in camp that night there came a wild thought of Alabama's highest point, isolated Mt. Cheaha, a hundred miles south in Talladega County. Pulling a long shot, we packed lunch next morning, took to the mountain road which became poorer and very dusty through the forest climb up Cheaha, and by noon were enjoying this lunch seated amid Cumberland Azalea right on the summit of the mountain! They were a little past bloom but there was ample color to aid recognition of this gratifying find at a lone point so far from Kentucky and Yahoo Ridge. But this was no large batch of azaleas; beneath the windbent oaks were perhaps a few hundred plants in this colony which must have been isolated for a very long time. It was hoped that they might show something more of original characters or flower color but on superficial examination they were similar indeed to the little azalea we had followed so far. It is of passing interest that Rehder did not record the existence of a *calendulaceum*-like azalea in Alabama and that the reference in the Eighth Edition of Gray's Manual should properly refer to the Cumberland Azalea rather than to *R. calendulaceum* proper.

## The Texas Azalea

Two further geographic possibilities remained for this fascinating plant, the southward extension of the Cumberland Plateau south of the Tennessee River in North Central Alabama and — a very long shot — the Ozark Mountains of Arkansas and eastern Oklahoma which has azaleas and certain interesting representatives of other eastern plants. The next day, June 20th, was spent in the *R. alabamense* hills of Cullman and Winston Counties, but only late forms of the latter species were found, no Cumberland Azalea since the hills are perhaps too low and, strangely, not even any *R. arborescens,* which had been expected.

No collections were made on the long drive through Hot Springs, Arkansas to Mt. Ida for the night but luck was better during the next two days coverage of the principal mountain peaks of the Ouachita and Boston Mountains, the length of Rich Mountain and adjacent LeFlore County, Oklahoma, impressive Magazine Mountain, Flat Top Mountain and northerly White Rock Mountain in Franklin County, Arkansas. There was no Cumberland Azalea as had been vaguely hoped but local *R. oblongifolium,* the Texas Azalea, was found in several places with sufficient plants still in flower for at least representative collections. This generally white and rather small flowered species is confusing in that it so frequently grows side by side with a pubescent-leaved pink azalea akin to *R. roseum,* and evidently breeds with it; the white form may be more adapted to moist valley sites and the other to drier hillside slopes but the line of preference is not strong. There is needed an earlier season and more careful study of these Ozark plants than was possible in this too rapid survey.

On the third morning in Arkansas, on June 24th, the car was again headed back towards the now-passing eastern azaleas. It chanced to be a Sunday, with Sunday drivers in slow lines on the highways but nevertheless nearly 600 miles were covered before nightfall in eastern Kentucky. No azaleas were collected; none was seen and they were doubtless sparse to nonexistent over most of the rich agricultural land traversed.



Fig. 9. *Gregory Bald*

*Though not realized at the time, distinctive qualities of the Flame Azalea of the Nantahala region have previously been pointed out by Braun in *The Red Azalea of the Cumberlands,* Rhodora, 43: 33, 1941.

## Back to the Alleghenies

The next week was spent in a run north through the mountains of Virginia and West Virginia and back south into Tennessee and North Carolina in quest of late forms of *R. calendulaceum* and of northerly *R. arborescens* and *viscosum,* wherever it might occur. A last visit was paid to the late red azaleas of Kentucky's Big Black Mountain and more of the Cumberland Azalea was found in Wise County, Virginia, but farther east at elevations of 3000 ft. and above it gave way to the late phase of *R. calendulaceum,* mentioned earlier, which was also of plentiful occurrence on the high points of the Alleghenies from Grandfather Mountain and Mt. Pisgah, west to the Tennessee border. Throughout this tour the Sweet Azalea was fairly plentiful along streamsides of the upland valleys and in some places, as at Mountain Lake, Virginia, and on Great Pisgah in North Carolina, it was hybridizing freely with *R. viscosum* to produce variable and often pink-flowered hybrids quite similar to entire populations seen in northern Pennsylvania a month later.

The Sweet Azalea tends to be quite variable in certain characteristics and throughout its range from New England to Georgia and Alabama. It may be variable in habit from low, widespreading and bushy in open places to tall and leggy in denser woods; its foliage may be glaucous beneath or entirely green; its corolla may be pure white or carry yellow blotches of varying intensity and in flower size it may be a plant of mediocre attraction to one of quite outstanding quality. A clone with especially large and showy flowers was found on the east fork of the Pigeon River in Pisgah National Forest but others almost equally good were seen at intervals. Such individuals from the horticultural standpoint were quite superior to over-extolled "var. *Richardsonii*" of Wayah Bald whose flowers are medium in size and whose dwarfness seems a product of wind-swept exposure which is not expressed in the forest shelter at a few feet lower elevation.

## A Mountain-top Marvel

A fine fourth of July found the Chevrolet headed towards headquarters of the Great Smoky Mountains National Park in Gatlinburg, Tennessee, but wisdom prevailed in time for the effective substitution of a collecting detour over little-travelled Max Patch Mountain. Holiday makers had thinned somewhat by the next day, permitting a visit to Park Headquarters for the advice of Arthur Stupka, Park Naturalist, concerning the azaleas of the park and especially of now famous Gregory Bald on the park's southern rim. Representatives of the Gregory Bald population, as collected earlier by W. H. Camp, had been inconclusively studied previously and there was a real need to discover what this puzzling situation might actually be. Mr. Stupka was helpful indeed in providing access to the Park Herbarium and in giving suggestions on approaches to Gregory. A day's food supplies were laid in, the distance was covered to Cades Cove, a pack was made up with temporary presses, photographic equipment and a blanket and the stiff 4½ mile climb to the mountain top was started in rather late afternoon. A cabin at about 4,900 ft. elevation was reached at dusk, leaving just time to complete the distance to the summit for a preview of the azalea display before cooking supper and turning in for a night's rest. Unfortunately the "night's rest" was enjoyed in the damp cold against which one blanket afforded little protection. It was also amid rather noisy wildlife from inquisitively reconnoitering mice to larger creatures, perhaps bears, which by morning had spirited away my lone loaf of bread. But there was enough food for a good breakfast and with warming sunlight and the azaleas, discomforts were soon forgotten. (Fig. 9)

The azaleas of Gregory Bald are at first glance bewildering and almost unbelievable. The mountain is a true "bald" having a broad, grassy summit fringed by scrub trees leading quickly into vigorous deciduous forest. The origin of the bald is unknown but it is probably man-made, resultant from earlier Indian grazing. It is the marginal region between trees and the grass sod which supports a peripheral band of a bizzarre collection of azaleas — thousands of plants in every imaginable hue from pure white to pale yellow, salmon yellow, clear pink and orange-red to red. Many of the flowers are yellow blotched, many of the bushes are stoloniferous and foliage varies from normal to deep glossy green, often glaucous beneath. Obviously it is a complicated hybrid swarm dating, in the older plants, to perhaps thirty years ago when some happening such as a brush or forest fire may have been responsible for the start of this strange and fascinating collection. Assuming that these were in fact hybrids the evident procedure was to search for the species which might have been involved in the hybridization process. The red and red-orange colors were an obvious lead and bushes of a *Bakeri*-like late flowering phase of *R. calendulaceum* were soon recognized, particularly on the west and southern sides of the bald. Such azaleas had been observed lower on the trail on the approach to the summit. From previous experience the clear pinks suggested hybridization between a red and white and white clones gave surer evidence of a parent of this color. Glossy leaves and glabrous shoots suggested that one such white might well be *R. arborescens.* A

quick search for this species was unsuccessful but it too had been seen on the approach to Gregory Bald. That it actually grew in the vicinity of the Bald has since been confirmed by F. C. Galle of the University of Tennessee who has made a special study of this population. In the search for *R. arborescens* a visit was paid to nearby Parson Bald a mile to the south and on this mountain was found a splendid growth of a second white azalea, the dwarf and stoloniferous form of the Swamp Azalea, *R. viscosum,* var. *montanum* whose characteristic small, sticky flowers and suckering root system had also been recognized as being carried by many of the Gregory hybrids. *R. viscosum* may have been growing on Gregory itself or its pollen could easily have been carried this short distance by flying insects. Certainly it, with the other two species mentioned, was involved as an original parent of these plants. These three species are the only ones likely to be met at this elevation and in this particular region. Full collections were made of the Gregory population for later detailed study. While hybrid swarms involving as many species are not rare among eastern azaleas, no other yet seen has equaled this one in impressive size and effect. While many of the plants are beautiful from the horticultural standpoint it is fortunate that they are protected by National Park authorities for all to enjoy. Each color could be simply reproduced by cross-pollinating the same species under artificial conditions.

The study and photographing of this collection was still not complete by dusk, necessitating a second night on the mountain which was rendered slightly more comfortable by a harvest of fern fronds for softness and a little warmth. Dry cereal provided a slim breakfast next morning but work was completed in time for a rapid descent starting by noon.

Being reasonably close to Knoxville, Tennessee, a visit was paid to the University to discuss azalea problems with members of the Department of Botany and to review briefly a fine set of herbarium material well worthy of later study. This was July 9th and since more late material was still needed from the mountain areas a route was chosen via Wauchecha Bald in Graham County, North Carolina, Robbinsville, a return to Wayah Bald via the Winding Steps road, a northern swing over Cowee Bald, memorable for dew-laden red azaleas and a brilliant sunrise over its cloud filled valleys, and thence to Highlands, North Carolina. The principal collections of this tour consisted of *R. arborescens,* late specimens of the red-orange Flame Azalea including an especially fine stoloniferous clone in full bloom near Nantahala Lake on July 10th, and *R. viscosum,* var. *montanum,* also in excellent bloom, pure white, in low thicket



Fig. 10. *R. arborescens*

growth in open woods near Highlands. Occasional hybrids of this plant with the Sweet Azalea can be striking with their large pink flowers, as are similar hybrids with *viscosum* itself at lower elevations. (Fig. 10)

### The Plumleaf Azalea

It being now the 12th of July a reference to the collecting map indicated that the late red azalea of Georgia, *R. prunifolium,* should be in flower. Its type locality is near Cuthbert in Randolph County, southwest Georgia, and in this direction the Chevrolet was turned from the hillsides, the rhododendron forests and the delightful climate of Highlands, North Carolina. The only detour made in crossing Georgia was in search of the Sweet Azalea at the southernmost part of its range in Upson County of central Georgia. The search consumed nearly a full day but the azalea was at last found in splendid quantity and, strangely enough, in full bloom in spite of this low elevation so far south. In pure white flower it followed the banks of a small Moccasin-infested tributary of the Flint River, the same azalea by all outward characteristics as its counterpart of 800 miles away in West Virginia.

Fort Gaines, Georgia, is a sleepy little town on the banks of the Chattahoochie, the river separating Georgia and Alabama which, 75 miles farther south, joins the Flint River (from Upson County)

to become the Appalachicola of northern Florida. Both Fort Gaines and Cuthbert, twenty miles northeast, are situated in a region where the clays of the rising Coastal Plain have been cut into deep gullies by small meandering streams. The sides are often so steep that the only access is by wading the stream, and one is almost forced to do this (in spite of the Water Moccasins) by the dense cat-briar tangles of the wooded surroundings.

It is in these gullies of a few Georgia and Alabama counties, generally centering on Fort Gaines, that the Georgia late red azalea, *R. prunifolium,* is at home. (Fig. 12) Here, on steep slopes, wherever enough light has penetrated to permit flowering, it is found in round-topped bushes up to twelve feet high in reds, red-oranges, apricots and orange-yellows. The color range is not far different from that of the Cumberland Azalea and after seeing the latter for so long one is impressed by the similarity between the two. They both have those characteristic ridged flower tubes in the bud stage; they are both late, both red, and in more detailed morphology have little to show reason why they could not be quite logically and quite possibly regarded as high and low elevation derivatives from a common ancestor. By its lateness of bloom and geographic isolation *R. prunifolium* has not had the opportunity for recent gene exchange with other species. Thus it lacks the aggressive adaptability of its mountain counterpart, so that now, even in its chosen locale, young seedlings are seen so infrequently that one wonders how much longer it may persist without more effective protection than it now receives. (Fig. 11).

The type locality for this species, 2¼ mi. N. E. of Cuthbert, is now a golf course with no azaleas evident but a good collection was made in a small ravine 1¼ miles distant. The visit to Fort Gaines also provided an opportunity to discuss mutual



Fig. 11. *R. prunifolium*



Fig. 12. *R. serrulatum*

interests with that authority on southern azaleas, Mr. S. D. Coleman, who not only showed me his own unusual plants, so well tended and arranged, but who also provided a valuable lead to a curious little May-flowering white azalea of Central Georgia and Alabama, hitherto overlooked. The next day or so was spent in following this low growing plant, now past bloom, as far as Mississippi. On a basis of characteristics which lie somewhere between *R. viscosum, serrulatum* and *oblongifolium,* it has not yet been taxonomically assigned as a previously described entity and should certainly be credited to Mr. Coleman if a new designation is warranted.

### HAMMOCKSWEET

Returning to Mississippi on a stifling 18th of July with the thermometer hovering around 104°F. the first plants of true *R. serrulatum,* the Hammocksweet Azalea, were found in flower the day following on the edge of a wooded swamp in Jones County. (Fig. 12) Through the following week and a half, it was chased in equally good flower into southeastern Louisiana, east around the Gulf Coast to within a few miles of Lake Okeechobee in South Central Florida, back to its type collecting locality in Lake County, Florida, north again to the edges of the Okefenokee Swamp and again east to Folkston, Georgia, and the type locality of Rehder's *R. serrulatum* var. *georgianum.* Throughout this thousand miles and more the Hammocksweet Azalea showed no excessive variation. At times it is true that its leaves or dormant buds became more silky pubescent, its flower pedicels varied from pale green to deep red in color and its flowering season was obviously

prolonged in lower Florida where single individuals may bloom from July to October or later, but essentially it remained the same sticky-tubed and rather inconspicuous little white azalea of the bog tussocks and the cypress islands of the southern waterways. At times it formed rounded bushes ten feet tall, but it was often low or producing but a few rangy stems seeking light through a dense cover of vine-covered holly or palmetto. The very late flowers of individual specimens could well be a characteristic worthy of exploitation in some future race of garden hybrids.

### THE NORTHWARD RETURN

With good collections of *R. serrulatum* one could feel with fair satisfaction that the gamut of southern azaleas had been about run, until such time as return visits to puzzle areas might be called for in another year. A northward return was thus in order, so planned as to catch any further outliers of the *R. serrulatum* complex together with a fairly detailed survey of its northern counterpart, *R. viscosum,* which should now be in scattered bloom well into New England.

Leaving Folkston on the 28th of July, our route headed towards Savannah and the Georgia side of the Savannah River where late azaleas had been observed during the *R. speciosum* season. The only collections this day were of fine specimens from a northerly distribution of *Befaria racemosa,* the curious ericaceous Tar Flower which, with its spikes of pink blossoms, is suggestive of a primitive azalea form. Here in coastal Georgia it grows on dry soils of the Pine-palmetto forest. Farther south the scattered clumps of this single North American representative of a Central and South American genus is a frequent sight along the Florida roadsides.

Occasional Hammocksweet Azaleas were seen on the way to Savannah while, bypassing this city, the first low white azaleas resembling *R. viscosum* rather than *R. serrulatum* were found at a woodland edge in Effingham County. Farther along, in Screven County, there was found a swamp near Oliver where the swamp tussocks were covered with quite normal *R. serrulatum,* the swamp margins with a very variable dwarf and stoloniferous azalea, sometimes highly pubescent in its buds and leaves which was clearly much more akin to *R. viscosum* than the other species. On drier land an outer circle of *R. canescens,* past bloom, completed the azalea picture. This was the last collection of *R. serrulatum,* which does not seem to spread north of the Savannah River. It is clearly a region where the two late white azaleas meet and as such it is likely that gene exchange with resultant variability could be expected here in East Central Georgia.

Crossing the Savannah River on Route U.S. 301, this road was followed north to Baltimore, as it parallels the coast some 100 miles inland. Throughout the distance of the Carolinas, Virginia and Maryland, *R. viscosum* was mass-collected, usually in good bloom, at intervals of approximately 60 miles. From Baltimore it was followed past Philadelphia into New Jersey, across New Jersey to Connecticut, and across Connecticut and Massachusetts to Cape Cod and even to the island of Martha's Vineyard where it was flowering on August 8th. This was another thousand mile run in which the variation of one species could be observed, step by step, until it became a fascination that terminated only as the last plants were collected. From the dwarf, twiggy and semi-evergreen bushes of the marshes of South Carolina to the tall, gray leaved and large flowered shrubs of the pond margins of Cape Cod, the Swamp Azalea is much more changeable than its sister of the Gulf Coast. Rehder has divided it into eight varieties and forms. One could make these many more, or less, depending upon the viewpoint of the observer. It seems certain that not a little of the trouble is due to *R. viscosum* and *arborescens* having met on occasion in the northern states, as was strongly suggested by the last New York State and Pennsylvania collections on the return to Philadelphia. In some of these northern swamps genes have been so freely exchanged between these two species that nomenclatural assignment of present populations becomes virtually impossible. The situation is similar to that previously noted with regard to *R. roseum* and *nudiflorum.* But in spite of these local happenings, *R. viscosum* can still be regarded as "good" a species, though variable, as *R. roseum, nudiflorum* or *serrulatum.*

This last run from central Pennsylvania to Philadelphia was on Sunday, August the 12th, and thus ended, after 21 weeks and 25,000 miles of almost continuous collecting, our quest for native azaleas. A few additional collections have since been made, as doubtless there will be others in the future. From this major field survey were secured 8,000 herbarium specimens and 500 living plants whose study should throw much new light upon the nature and the behavior of these plants. The herbarium specimens, now mounted and catalogued, are deposited in the herbarium of the Morris Arboretum of the University of Pennsylvania, at which institution the collection of living plants is also maintained for future observation and for their use in current cytological studies.*

*Editor' Note: Dr. Skinner also prepared, as a matter of record, a listing of herbarium and living collections. This is available in mimeographed form and will be furnished without cost, on request, to libraries, herbaria or individuals.

# ARBORETUM ACTIVITIES

*(Continued from page 14)*

come to the Arboretum primarily to see representative collections of such ornamentals as crabapples, lilacs, azaleas and magnolias, or such special-purpose forms as ground-covers, hedge-plants or climbing vines, the new plan has as its main objective the concentration of large and important genera on carefully selected sites.

This is a long-term project, but considerable progress has already been made in the setting out in their permanent areas of material from our own nurseries as well as plants secured from other sources. There already exist noteworthy collections of hollies, azaleas and boxwood not far from Gates Hall, while on the area north of Northwestern Avenue a basic representation of fine varieties of lilacs has been established. This will be augmented by additional varieties as they become available. Nearby areas have been designated for *Ligustrum* and *Forsythia* and some members of these groups are already in place. A conspicuous location on a low, south-facing slope has been selected for the flowering crabs and cherries and a beginning has been made in the building up of a really fine display of these spectacular plants. The location of many other groups has been determined and specimens have already been or soon will be set out in their permanent sites.

### Michaux Quercetum

The nature of this unique project, which was initiated in 1953 under a grant from the American Philosophical Society, was described by Dr. J. R. Schramm in a previous issue of this Bulletin (Vol. 5, No. 4). The purpose, briefly, is to grow in especially prepared seed beds and under rigidly observed conditions acorns from as many different species of oaks as are hardy in this area. In order to make possible comparative studies, acorns of the same species from representative portions of its natural range are desired and whenever possible, 100 acorns of a single collection are planted.

By the end of the first season (1953) about 13,000 acorns, representing 37 species and 23 states, were planted. Of these, more than 8,300 germinated and grew during the season of 1954. This spring, after having spent two winters in the seed beds, these seedlings are being transplanted to a nursery where, during the coming summer, continuing observations will be made of their performance.

Meanwhile, during the autumn of 1954, over 10,000 additional acorns, representing 29 species and 19 states, were received and planted. This required the construction of two new rodent-proof seed beds in addition to the three already in existence. It is planned to continue this project in future years and to extend the area of collecting to include portions of Europe, the Near East and the Orient. The Arboretum is grateful to the many collaborators who have collected and forwarded seed lots from their local areas.

### The Langstroth Bee Garden

This unusual and attractive garden devoted to the growing of trees and shrubs which are important honey plants, was dedicated with appropriate ceremonies on October 20, 1951 (See Vol. 5, No. 2). Mr. Fred W. Schwoebel, an eminent apiarist who devotes a great deal of his time to the garden, has suggested the addition of a considerable number of species which are visited by bees. This has already been largely accomplished and at the same time the collection has been rearranged to create a more pleasing appearance and provide for easier maintenance.

### The Nurseries

The grounds of the Arboretum contain six nursery plots, some of which were started as long as twenty years ago. Some of the surplus stock in these plots had become too large for transplanting and, since it occupied space needed for other purposes, much of it is being or has been destroyed, care having first been taken to secure propagating material from the more valuable species. There still remains a considerable amount of surplus material suitable for transplanting and it is our policy that this should be disposed of in the following manner:

a) Whenever needed for planting on the campus of the University of Pennsylvania surplus material should be made available from the Arboretum nurseries. This policy is already in effect and this spring a considerable amount of plant material has been transported from the Arboretum to the University for the purpose of beautifying the campus.

b) Surplus material is being offered to other arboretums and botanical gardens which in turn furnish us with plants needed to round out the collections of the Morris Arboretum. Since July 1, 1954, more than 500 items have been sent out from here on this basis of exchange.

### Seed List

Most important arboretums and botanical gardens throughout the world annually distribute a list of seeds available in exchange. This had formerly been done at the Morris Arboretum but the practice had been discontinued two or three years

ago. It has now been reinstituted and in the autumn of 1954 a carefully selected list of seeds available at the Morris Arboretum was distributed to the institutions on our mailing list.

The seed list for this year was a small one containing 30 items and one special offer (a limited quantity of control-pollinated seeds of azalea from our breeding experiment gardens). Thirty-six requests for seeds from this list were received — nine domestic and twenty-seven from fifteen foreign countries. In all, 152 packets of seed were distributed.

### Northeast Forest Experiment Group

Since 1942 several staff members from the Northeast Forest Experiment Station have been housed at the Morris Arboretum and have utilized our facilities in the laboratories, greenhouses and nurseries. In return, the presence of this group has provided an intellectual stimulus for members of our own staff, and the relationship has proved a happy one. It is our hope that this program of mutual cooperation will long continue.

Before coming to the Morris Arboretum, Dr. Ernest J. Schreiner, Geneticist-in-Charge, looked over various possible locations from Boston to Washington, D. C., and found out that the Philadelphia area offered the greatest number of mature exotic trees for breeding purposes of any region in the East. This interest in exotics stems from the fact that the Philadelphia area was the center of botanical activities in colonial times.

### Educational Plans

It was the expressed wish of the late Lydia T. Morris, who generously bequeathed her estate to the University of Pennsylvania, that the Arboretum should render an educational service stemming from its rich and varied collection of native and exotic plants. This is a project which needs to be carefully studied and well organized, and a great deal of attention is being given to it in our frequent staff meetings. At present we can only point to the fact that numerous organizations (horticultural societies, garden clubs, Scout groups, etc.) who come to the Arboretum are given specially guided tours or informal lectures on such subjects as may interest them. A great deal needs to be done to expand this type of service and even to offer regular courses of instruction comparable to those given at the Arnold Arboretum, the New York Botanical Garden and the Morton Arboretum.

This coming summer the Director and members of his staff will offer a course on Woody Plant Materials, which will be open to students in the University's Summer School Session.

### Public Relations

The present Director is keenly aware of the fact that the Morris Arboretum possesses a high potential for service to the community and is eager to make the resources of the Arboretum available to an ever-widening circle. Attention is therefore currently being given to methods which will bring about an increased number of visitors, especially at such times as it may be possible, through dignified publicity, to highlight the attractiveness of special groups of plants, such as magnolias, azaleas, roses, etc. The Director has recently accepted the co-chairmanship of the Landscape Committee of the Chestnut Hill Development Group. This serves to establish a close relationship between the Arboretum and the community in which it is located.

### Recreation Area

Plans have been completed for the establishment of a small recreation area along Wissahickon Creek near the mill. This will include rest rooms, an outdoor fire-place and playing fields for softball, horse-shoes, badminton, etc. Funds for this purpose have been made available by the Undergraduate Council and the Women's Student Government Association of the University of Pennsylvania and the area will be available after May 1 for outings and picnics scheduled by students and alumni of the University. Outside organizations may also apply for use of the area, but preference will be given to student groups which have made possible its creation.

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*New Boxwood Planting at the Arboretum*

GRAY HERBARIUM
RECEIVED
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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

## ARBORETUM ACTIVITIES

### *Summer Course*

During the six weeks of the University's Summer School, June 27 to August 6, a course in Hardy Ornamental Trees and Shrubs was conducted at the Arboretum. Instruction was given by the Director, assisted by Dr. Hui-Lin Li and other members of the staff. This was the first college-level course ever offered on a full-time basis by the Arboretum and marks the beginning of the expanded educational program mentioned in the last number of the Bulletin.

Fourteen students enrolled for the course this summer. Five of them were members of the University's School of Fine Arts who took the course in order to gain a better knowledge of plant materials and their role in landscape architecture. Four were teachers of biology in secondary schools in the Philadelphia area. The rest were undergraduate or graduate students, mostly majoring in biology or botany, from nearby colleges or universities.

Work tables were set up on the broad verandah of Gates Hall overlooking one of the most beautiful sections of the grounds. Here, on even the hottest day—and this summer was replete with such—a cool and refreshing breeze moved up the slope toward the "classroom."

The first week and a half of the session was devoted to a study of the Gymnosperms—pines, larches, firs, spruces, cedars, hemlocks, junipers, cypresses, yews, etc.—and the members of the class learned not only how to distinguish these groups but also how to recognize the various important species of each genus. After working with twigs and leaves in the laboratory, and acquiring practice in "keying them out," the group then moved out onto the grounds and learned a great deal about the living specimens. In this way it was possible for them to see the size and shape of the mature plant and to study the conditions under which a particular species achieves its

*(Continued on page 35)*

# CERCIDIPHYLLUM

Hui-Lin Li

Cercidiphyllum or Katsura-tree is one of the most impressive trees of the temperate regions, attaining, as it grows in age, an immense size which surpasses most other broad-leaved trees. Of graceful habit and handsome foliage, it is highly ornamental in appearance. Botanically it is considered important and interesting because, with its certain distinctive and primitive features, it represents an isolated type of ancient lineage, a remnant of certain stocks flourishing in earlier times.

Cercidiphyllum is the only genus of the family Cercidiphyllaceae, one of several such small relict families of the alliance of the Magnoliales now surviving in eastern Asia. The Magnoliales are an assemblage of woody plant families considered by most botanists as representing the most primitive types of flowering plants now in existence.

Cercidiphyllum is a deciduous tree with opposite or sometimes subopposite or nearly alternate heart-shaped leaves resembling those of Cercis, the Judas-tree, hence the name Cercidiphyllum, meaning "Cercis-leaf." (Fig. 13.) The leaves, however, are finely and shallowly toothed instead of




Fig. 13. *C. japonicum*. A. leafy branch, ½ natural size. B. branch with staminate flowers, natural size. C. branch with pistillate flowers, natural size. D. branch with fruits, natural size.

entire. The bark is characteristically spirally twisted and furrowed. The shoots also develop short spur-branches which bear the flowers and a single leaf, a very unique feature. These lateral spurs are formed by annual accretions added slowly over a period of years. Also distinct is the structure of the flowers. The trees are dioecious, that is, the flowers are unisexual with the staminate and pistillate appearing on different trees. The inconspicuous flowers have a few small bracts but are without a perianth. The staminate flowers have numerous stamens with slender filaments and linear red anthers. The pistillate ones consist of 3-6 carpels with long purple styles. These flowers are of interesting structures and botanists are not in full agreement as to whether they should be considered individual flowers or inflorescences. The carpels develop into dehiscent small pods containing many small winged seeds.

The genus occurs in Japan and China. (Fig. 14.) In Japan, the Katsura-tree, *C. japonicum* Sieb. & Zucc., occurs widely from central Hokkaido in the north through Honshu to Shikoku and Kiusiu in the south, covering nearly the entire length of the country. Katsura means a wig. The application of this name to the tree is not clear. In the north in Hokkaido, it grows at sea level and is very common. On the main island Honshu it is confined to high elevations mostly above 5,000 feet and is rather rare. It is a tree of the forests, preferring rich soil and moist situations.



Fig. 15. *C. japonicum,* var. *sinense.*

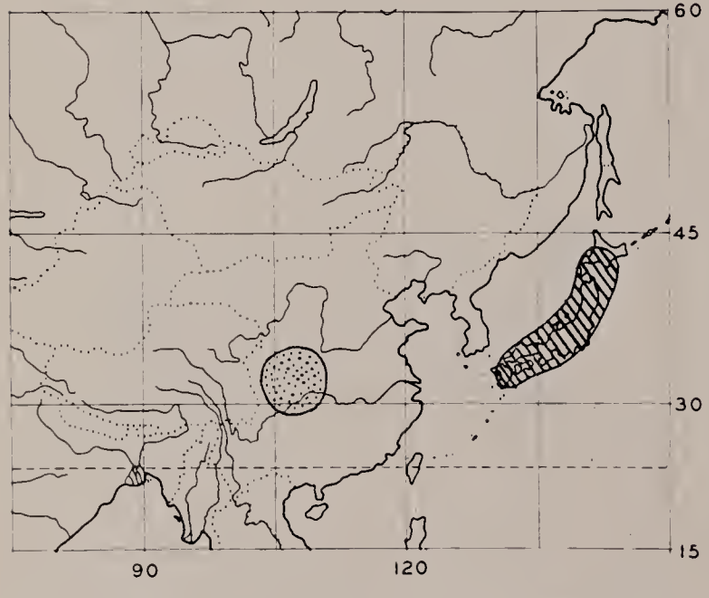



Fig. 14. Map showing range of *Cercidiphyllum.* Shaded area, *C. japonicum;* dotted area *C. japonicum,* var. *sinense.*

Some Japanese botanists also recognize two additional species, *C. ovale* Maxim., with narrower ovate leaves and *C. magnificum* Nakai, with larger leaves. Both are of local occurrence in Honshu only. Others, however, do not consider these as distinct species but merely as synonyms of *C. japonicum.* Some recognize the latter as a variety, *C. japonicum,* var. *magnificum* Nakai. The leaves of *C. japonicum* are said to measure 1¼-2¾ in. across, while in the variety *magnificum,* they attain to a diameter of about 2¾-4 in. However, leaves of oval as well as cordate shapes and leaves ranging from 1¼ to 4 in. in diameter are often found on the same tree in both herbarium and cultivated living specimens. These variations alone are apparently not worthy of specific recognition.

The Chinese Cercidiphyllum occurs in western China, over a thousand miles west of Japan, in eastern and western Szechuan, western Hupeh, and southern Shensi, at an altitude of 5,000 to 8,400 feet. It, like the Japanese plant, prefers moist situations and rich soil, but grows in more open areas, occurring most frequently on the banks of streams.

The Chinese Cercidiphyllum is considered a variety of the Japanese Katsura-tree, as *C. japonicum,* var. *sinense* Rehder & Wilson. The two are different somewhat in their habit and on slight morphological grounds. The Japanese Katsura-tree has usually several trunks diverging from the base. The Chinese plant has usually but one trunk which branches laterally several feet above the ground, the trunk sometimes remaining free of branches for nearly 50 feet. It is also a taller tree. Morphologically, it has shorter petioles and less deeply cordate leaves, the latter also somewhat hairy beneath along the veins instead of entirely glabrous as in the Japanese plant.

The Japanese Katsura-tree usually grows to a height of 30 feet but occasionally to nearly 100 feet as the tallest broad-leaved tree in their forests. The Chinese Cercidiphyllum, which occurs in abundance in some areas in western China, grows to a height of 120 feet and is the tallest and largest broad-leaved deciduous tree throughout all eastern Asia. It also attains a great age.

According to Wilson (2), who collected the tree in western China, the tree is called locally "Peh-k'o", meaning "white-fruit," the colloquial name of Ginkgo all over China, "owing doubtless to some obscure resemblance in the foliage and general appearance of the two trees." It is interesting to note that Sargent (3), observing this tree in the forests of northern Japan, notes that "in port and general appearance of its foliage Cercidiphyllum might at first sight be mistaken for a Ginkgo tree." Aside from the similar majestic appearance of venerable old trees of these two species, it is to be noted that there is a distinctive similarity between the two, the presence of short spur-branches on the shoots, a feature rarely found in other broad-leaved trees.



Fig. 16. *C. japonicum*, var. *sinense*.



Fig. 17. *C. japonicum*.

The Japanese Katsura-tree was introduced into cultivation in America in the latter part of the last century. Rehder (1) gives the year as 1865. Sargent, in 1893 (3) mentions that seeds were first sent to the Arnold Arboretum from northern Japan fifteen years ago, which makes the date around 1878. It is always one of the most impressive trees in botanical gardens whenever it is planted. It is attractive for the dense pyramidal habit with spreading branches and the handsome foliage. The leaves are purplish when unfolding, changing to bright yellow and sometimes scarlet in the fall. Its huge size does not fit it into a small garden, but on larger grounds, it often becomes a tree of great distinction.

The Chinese Cercidiphyllum was introduced into cultivation by E. H. Wilson. Rehder (1) gives the date as 1907. It was first described by Rehder and Wilson in 1913 (2), listing, among others, two October collections apparently with which seeds were procured (4). One of them is Wilson 4301, collected in 1910 from Lungan, western Szechuan, which they designated as type. The other, Wilson 742, was collected in 1907 from Fang Hsien of western Hupeh.

Both the Japanese and the Chinese trees are represented by large full grown specimens at the Morris Arboretum. The Morris Arboretum received from the Arnold Arboretum in 1912, a plant of Wilson 4301, subsequently designated as the type collection of *C. japonicum,* var. *sinense.* The tree is a pistillate one with a trunk now measuring nearly 5 feet in girth. (Fig. 15.)* The trunk is straight and it branches at about 5 feet above the ground. (Fig. 16.) A much older and larger Japanese tree, a staminate one, branches at the very base with a girth of about 12 feet. (Fig. 17.)

*Photographs in this issue by Dr. Ernst J. Schreiner

No record of this tree is extant, but judging from its age, this apparently belongs to Sargent's early introduction of over 70 years ago. Besides the difference in their branching, the foliage characters of the Chinese and the Japanese trees are very close. The Chinese tree has in general smaller, less deeply cordate leaves and with slightly shorter petioles, but the leaves are nearly entirely glabrous beneath just as in the Japanese plant.

Cercidiphyllum can be grown from seeds or by green-wood cuttings and by layering. It grows rapidly at first. In its young state, it is fastigiate in habit. When old the principal branches are spreading. They become gradually drooping and the slender tips and branchlets are often decidedly pendulous.

The wood of Cercidiphyllum is light, soft and yellow to light brown in color. Its sap and heart woods show a marked difference in the shade of the color. It is very straight grained and easily worked. It is used in China for making furniture, wood carvings and utensils. In Japan, it is often used for cases, packing boxes, and as a cheap material for interior finish of houses.

Cercidiphyllum is remarkable in that it is almost entirely free from fungus and insect diseases. Nature has apparently selected and preserved a sturdy enduring stock. Wilson notes that, in its native haunt in western China, it is very tenacious of life. He observes old, hollow stumps, broken down by wind and partially destroyed by fire, still continue to develop green leafy branches until utterly destroyed and up-rooted. Some of these old hollow stumps, showing still signs of life, measure nearly 50 feet in girth.

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# THE DISEASES AND CARE OF BOXWOOD


A. G. Smith, Jr.
Associate Horticulturist,
Virginia Polytechnic Institute


Boxwood in its various forms is a valuable ornamental plant. Many specimens known to be more than 100 years old are found growing in Virginia.

Contrary to general belief, boxwood is a vigorous plant. In good soil it requires but little care. Its development varies with the species or variety and with the conditions under which it is grown.

No diseases of importance affect boxwood; however, numerous fungi may be found on leaves and stems after these parts have been weakened or killed by other causes. There is growing in a Blacksburg, Virginia, yard a hedge of tree boxwood and a number of good dwarf plants which were rooted from twigs thought to be diseased. The twigs had been sent to V. P. I. from various sections of Virginia for inspection.

A study of thousands of plants in Virginia shows that injury or death may be caused by one or more of the following:

I. Damage to roots by:
   1. Digging or cutivating in the root area.
   2. Soil washing away from roots, thus exposing them to the elements.
   3. Planting too deeply.
   4. Making a cone of soil or mulch around the plant, causing the water to run away from the roots.
   5. Mulching too heavily, excluding air from roots.
   6. Applying caustic materials or excessive amounts of fertilizer.
   7. Moles and other rodents making burrows among roots.
   8. Poorly drained soil.
   9. Poorly prepared soil.

NOTE: This article first appeared, under the title "Boxwood," as Circular 503 of the Agricultural Extension Service, Blacksburg, Va. Because we consider it one of the most comprehensive treatments of this important subject ever to have been published, we have secured the author's permission to make it available, in slightly revised form, to our readers. We therefore desire to express our acknowledgment to the author as well as the Extension Service at Virginia Polytechnic Institute and the United States Department of Agriculture Cooperating. Ed.

II. Damage to leaves and branches by:
   1. Chemical sprays.
   2. Removing leaves by clipping to maintain formal effects instead of cutting out weak branches at top to admit light and air.
   3. Winter killing.
   4. Accumulation of soot on foliage; effect of smoke and gases.
   5. Mechanical injury from sleet and snow, bending and breaking the branches.
   6. Dead leaves accumulating inside dwarf plants.
   7. Crowding by other plants or by buildings.
   8. Sunscald and browning, resulting from weak condition of plant.
   9. Frost killing tender foliage and branches —rarely injurious to the whole plant.

III. Damage to entire plant by:
   1. Lack of water in dry seasons.
   2. Lack of reasonable supply of humus and fertilizer.

## PESTS

Mites (red spiders) are rarely found on vigorous plants. They may damage boxwood as to appearance, and in severe infestation may check normal growth. Soap spray will kill mites if it strikes them. Use one ounce of mild soap to a gallon of water. Wash all soap from foliage with water the following day. Repeat if necessary. Dusting sulphur may be used to control mites, provided it is never used in the same season with oil sprays. Apply dusting sulphur when the foliage is dry and use it in early spring. Sulphur may burn foliage in hot weather.

Boxwood leaf miner is the only serious insect pest. It has been spreading for many years. Instead of destroying all infested plants, owners often refuse to do this and then depend on halfway control measures. The leaf miner may be killed by spraying all leaf surfaces (inside and outside the plant) about one week before any flies emerge with one ounce of 50 percent DDT wettable powder in three gallons of water. This treatment should be repeated within six to eight days. Since DDT kills the insects which normally eat mites (red spiders) and does not harm the mites, it is usually necessary to take special measures to control mites after applying DDT.

Psyllids (whitish sucking insects) feed on the tender new growth and cause the leaves to curl. They disfigure the plant but cause little injury. G. W. Underhill, associate entomologist, Virginia Agricultural Experiment Station, recommends spraying the plants inside and out with nicotine, about May 25, in eastern Virginia and June 10, in western Virginia. The chemical may be applied in dust form.

Nematodes may be found on boxwood roots, especially in sandy soil and in poor soils low in humus. Apply a complete fertilizer and a light mulch of manure in March. Water when necessary.

So-called wilt follows winter injury, or possibly some form of mechanical injury to the terminal twigs. The injured or girdled portion of the stem usually occurs about 6 to 8 inches from the tip on tree boxwood and about 4 to 6 inches on dwarf types. For the sake of appearances, these twigs with reddish, yellow or dead leaves may be removed.

## CARE OF BOXWOOD

Most boxwood troubles are man-made. In a fairly good environment, this grand old plant can take care of itself.

Many yards have been filled with soil from the basement. The grading is often done when the soil is muddy. The soil bakes in dry weather and stays "tight" and soggy in wet weather. Boxwood does not succeed on such soil regardless of the amount of fertilizers added. The safest plan in such soil is to dig a large hole where each boxwood is to grow and fill in with good loam.

Boxwood will grow in moderate shade or in full sunlight. Morning sun in winter may cause damage by rapid thawing. It is a shallow-rooted plant and cannot survive planting too deeply or digging around roots.

It is not necessary to fertilize boxwood every year. Needs will vary widely depending on the type of boxwood used, the soil, and growing conditions. Over-fertilization may call for excessive pruning to keep the plants within bounds. A little chicken manure and a light application of bonemeal or superphosphate may be scattered around the plants in February or March, if the appearance of the plant suggests that fertilizer is needed. Never cultivate close to the plants.

Pruning boxwood is a necessary and important operation. The best time for pruning is just before growth starts in the spring. Start by removing weak and crowded branches from the top center of the plant. Where necessary, shorten the larger branches. Continue this thinning of branches over entire upper half of plant. This operation will keep plant at the desired size. In dwarf plants, remove all dead leaves that have fallen into the branches.

Never clip boxwood as you would a privet hedge. (It is regularly so clipped in Britain, Ireland, Spain and Italy for topiary work.) Endeavor to develop a stocky growth, which will hold loads of ice or snow and withstand buffeting by storms

without bending the limbs. This sturdiness can be attained only by annual thinning.

Allow light and air to reach all parts of the plant. Crowding will kill the foliage and branches.

Water all newly set plants. Water others when dry .

Boxwood may be transplanted at any time of the year except when it is making new growth. Boxwood may be sprayed with lime-sulphur or oil, when these are properly used, but unless scale infests the plants, such drastic measures had better be omitted. Bordeaux mixture is frequently sprayed on boxwood. It will do no harm, and probably will do no good.

## SOME OTHER FACTORS

Boxwood may not show the effects of injury until six months or a year after the injury occurs. It may take 4 or 5 years for larger branches to die after the surface roots are cut by digging. Boxwood can compete successfully with wiregrass and other grasses and weeds, if these plants are kept mowed. Any attempt to dig these grasses out will injure the boxwood roots. Only a part of a boxwood plant may die when a part of its root system is damaged. Such dying may be seen in almost any flower border surrounded by dwarf boxwood.

Boxwood is native to East Asia, Asia Minor, including Turkey and Iran, North Africa, and Southern Europe, and also occurs to a lesser extent in the West Indies and Central America. There is no American Boxwood and none native to England.

*Buxus sempervirens* is the common box tree, while *Buxus sempervirens* var. *suffructicosa* is the one commonly referred to as Dwarf Boxwood or English Boxwood.

Among the thirty-odd other known species of *Buxus* are *japonica, microphylla, balearica, Fortunei, Harlandii,* and *Wallachiana.*

Variations in boxwood are endless. There are many thousands of different strains or varieties. It is probable that each of these came from an individual seed at some time in the past.

In the V. P. I. Arboretum of the Virginia Agricultural Experiment Station, Blacksburg, there are now growing more than 1,200 seedlings of tree boxwood. No two in the group are exactly alike. Some are vigorous and upright; some are dwarf in habit; others are "intermediates." Originally there were about 5,000 seedlings in this experimental planting. The weaker ones were removed over a period of years by weather and by culling.

Following the severe winter of 1935, a block containing about 1,200 three-foot tree boxwood was examined in a Virginia nursery. Half of the plants had been propagated from cuttings taken from a plant purchased in one community. The rest were propagated from a different plant growing about 35 miles from the first community. The severe weather killed all the plants from one community while those from the other were green. Although the two parent plants looked alike, they varied in their resistance to cold.

Tree boxwood normally produces seed when the manufactured food (carbohydrates) greatly exceeds the available nitrogen. Sometimes one branch may blossom and bear seed while none is produced on the remainder of the plant. While the seed are of interest in research work, they do not offer a practical means of propagating a particular type of boxwood.

Propagation—Boxwood may readily be propagated from cuttings. These will root at almost any time of the year. For outdoor rooting, place the cuttings in sand or in sandy soil from July 15 to September 15. Protect from direct sunshine and from wind. Keep the bed moist. If cutting wood is abundant, make cuttings 6 inches long for dwarf box and 10 to 12 inches for tree type. Small cuttings may be put in greenhouse or cold frames as late as November.

# BOXWOOD AT THE MORRIS ARBORETUM

Although about forty named varieties and forms of boxwood are growing at the Arboretum, all but a few of them belong to a single species: *Buxus sempervirens,* the so-called Common Box, a native of southern Europe, western Asia and North Africa.

Many fine specimens of boxwood may be seen here, especially on the slopes above the Rose Garden, where are found some of the oldest and largest plants on the grounds.

Several years ago a new planting of boxwood was established near the northwest corner of the Rose Garden. Here the visitor may inspect many of the newer varieties and see for himself what a diversity of habit, leaf shape and color exists in this remarkable group of evergreen plants. (See Cover.)

While a great deal of study is needed before the classification of our boxwoods is clearly understood, it seems desirable at this time to place on record the following list of species, varieties and "forms" represented at the Morris Arboretum:

Buxus balearica
Buxus Harlandii
Buxus microphylla
" "Curly Locks"
" japonica
" "Kingsville 2A"
" "Kingsville Dwarf"
" koreana
" " aurea
" sinica
Buxus sempervirens (Anderson #350-35)
" (Anderson #351-35)
" (Anderson #352-35)
" (Anderson #789-34)
" angustifolia
" " elata
" arborescens
" aureo-maculata pendula
" aureo-variegata
" "Fairview"
" fastigiata
" glauca
" Handsworthiensis
" "Joe Gable"
" myosotifolia
" myrtifolia
" "Nish"
" nivicularis
" "Petch"
" "Prizren"
" prostrata
" pyramidalis
" pyramidalis (variegated form)
" rotundifolia
" salicifolia alata
" (spreading variety)
" suffruticosa

J. M. F., Jr.

# A FLOOD OF WATERS

On Thursday night, August 18th, eastern Pennsylvania was subjected to torrential rains spawned by Hurricane Diane and the next morning the lower reaches of the Arboretum presented a scene of watery desolation. Not only had the Wissahickon Creek overflowed its banks to inundate the lowlands of Bloomfield Farm, but a vast accumulation of water from the downpour had raged across Stenton Avenue and joined the Wissahickon overflow in the lower meadow east of Northwestern Avenue. By Friday morning the waters had receded from Stenton, but on Northwestern the abandoned car of some unfortunate motorist, who had overestimated the amphibian potentialities of his vehicle, stood up to its middle in the swirling waters. (Fig. 18.)

The students and faculty of the University who have enjoyed picnicking at the new Recreation Area on Bloomfield Farm would scarcely have recognized the sight which greeted us that morning. The entire field was submerged, the watery aspect broken here by the protruding chimney of the fireplace and there by the volley-ball standards, slightly askew and looking for all the world like the masts of a sunken schooner. George Campbell would not have to worry about mowing the grass this weekend! A dozen feet higher in the old mill we found that Tom Carney had marked the place

where the flood had crested the night before. Fortunately, Jim O'Neil, wisely heeding the hurricane warnings several days earlier, had lashed the picnic tables to a tree or we would have been looking for them down in Fairmount Park!

Contrary to Hurricane Hazel, which last year leveled at least fifty trees on the Arboretum, Diane caused no permanent injury to plantings. The principal damage was suffered by the Arboretum fence. Assaulted by tons of water and debris the fence had given way in approximately ninety places, creating an impression of considerable devastation. However, thanks to Dr. Schramm's idea of fastening certain of the fence panels together with half-inch lead bolts designed to break under pressure, the actual damage was not so great as met the eye. These lead bolts had been substituted for the original iron ones in a thousand feet of fence along Northwestern Avenue and in two hundred feet along Stenton where flood damage was anticipated. Since in this storm the water rose to unforeseen levels, a few iron-bolted sections of fence fell in the path of the flood. Here the posts were bent and twisted and proved costly to repair. Where the lead bolts had been substituted, however, the fallen panels had merely to be erected and bolted to the posts which had remained standing. (Fig. 19.) This work had just been completed two weeks later, the fence upright and intact once more, when a car, skidding on a slippery roadway, crashed into another post. We were in business again!



Fig. 18. Flood waters along Northwestern Avenue.



Fig. 19. Lead-bolted sections of fence showing posts still upright.

Aside from a few sections of washed-out driveway, the remainder of the Arboretum took the rains and flood in its stride. Water coming down from Hillcrest Avenue flowed off quickly, and the high banks of the creek near the greenhouses contained the flood at that point. In fact, after a summer of heat and drought, the rejuvenation of parched lawns following the rains made us realize that destructive though the storm may have been elsewhere, at the Arboretum it was not an unmitigated catastrophe.

J. L. B.

## LIBRARY ACCESSIONS

The following books have recently been added to the Morris Arboretum Library:

*Plant Regulators in Agriculture,* H. B. Tukey, Ed. (Wiley & Sons, 1954)

*Small Fruits,* Ralph E. Barker (Rinehart, 1954)

*Fruit in the Garden,* Norman Taylor (Van Nostrand, 1954)

*The Improved Nut Trees of North America and How to Grow Them,* Clarence A. Reed and John Davidson (Devin-Adair, 1954)

*The Rhododendron and Camellia Year Book 1955* (Royal Horticultural Society)

*Hardy Rhododendrons,* Frederick Street (Van Nostrand, 1954)

*Winter-Hardy Azaleas and Rhododendrons* (Massachusetts Horticultural Society, 1954)

*Evergreens,* L. L. Kumlien (Rinehart, 1954)

**The Story of Boxwood,* Clara S. McCarty (Dietz Press, 1950)

*The New Tree Experts Manual,* Richard R. Fenska (de la Mare, 1954)

*The Pruning Manual,* Everett P. Christopher (Macmillan, 1954)

*Plant Diseases,* Ernst Gram and Anna Weber (London, 1952)

*Beautiful Flowering Shrubs, Trees and Heather,* G. Clarke Nuttall (London, 1953)

***Important Trees of the Ryukyu Islands,* Egbert H. Walker (U.S. National Museum, 1954)

*Trees and Shrubs in Eastern North America,* Benj. Blackburn (Oxford University Press, 1952)

****Travels of William Bartram,* Mark Van Doren, Ed. (Dover Publications, Inc.)

*Winter Key to Woody Plants,* Arthur H. Graves (Pub. by the author)

*Directory of American Horticulture for 1954* (The American Horticultural Council, Inc.)

*American Rose Annual 1955,* Fred J. Nisbet, Ed. (American Rose Society)

* Gift of J. Churchill Newcomb
** Gift of the author
*** Gift of Dover Publications, Inc.

## NEW ASSOCIATES

The Arboretum has been happy to welcome the following new Associates:

Miss Margaret G. Butler
Mrs. Van Horn Ely, Jr.
Mr. Edward W. Evans
Mr. C. Jared Ingersoll
Mrs. Sidney Keith
Mr. Howard S. Levy
Mr. and Mrs. Francis Macdonald
Dr. I. S. Ravdin
Mr. Nicholas G. Roosevelt
Mrs. Elizabeth R. Vallier
Mr. J. M. Van Nieukerken
Mr. John W. Woerner

# Arboretum Activities

*(Continued from Page 26)*

optimum growth. The rich resources of the Arboretum as an outdoor laboratory were thus utilized to the fullest extent.

The remainder of the course was devoted to the Angiosperms, or Flowering Plants, and here the students had an opportunity to study over 200 important genera belonging to 60 different plant families. The emphasis at all times was upon acquiring a familiarity with the *method* by which plants may be identified rather than an insistence upon memorizing all of the several hundred species encountered.

Special attention was, of course, focused on such important ornamental genera as *Magnolia, Philadelphus, Spiraea, Prunus, Malus, Acer, Ilex, Enonymus, Hedera, Cornus, Rhododendron* (including *Azalea), Fraxinus, Syringa, Forsythia, Lonicera, Viburnum,* etc., and emphasis was laid on the characteristics and potentialities of a large number of "special purpose" plants.

Special instruction was given in methods of propagation of woody plants and the students learned how to make grafts and stem cuttings. Several members of the group were interested in

the preparation and use of herbarium specimens and the facilities were provided for them to acquire these techniques.

The success of this course, given in ideal surroundings for this type of instruction, indicates the desirability of offering it and perhaps other courses in future years.

*Recreation Area*

The recreation area, the establishment of which was mentioned in these Notes in the April issue, was formally inaugurated on May 2, when the Houston Hall Student Board held its annual spring outing on the grounds.

During the ensuing spring and summer months more than a score of organizations held picnics in the area. These included, in addition to a number of fraternities and campus clubs, such groups as the Senior Class of the Medical School, the American Society of Engineers, the Institute for Humanistic Studies, the faculties of the Moore School of Electrical Engineering, the School of Education, the Botany Department, the Statistics Department, and groups from LaSalle College and the Budd Company. Several other groups have scheduled outings to be held during the autumn.

Organizations desiring to use the recreation area should consult the office of the Dean of Men, 117 Logan Hall.

J. M. F., Jr.

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# Morris Arboretum Bulletin

DECEMBER, 1955

VOL. 6 NUMBER 4



*Pin Oaks at the Arboretum*

GRAY HERBARIUM
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The Morris Arboretum Bulletin is published quarterly at Philadelphia Pa., by the Associates of the Morris Arboretum, Chestnut Hill, Philadelphia 18. Subscription, $1.00 for four issues. Single copies, 30 cents. Free to Associates.

THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organizationwill be sent on request.

## ARBORETUM ACTIVITIES

The major project for the fall planting season has been an enlargement of the main Rhododendron collection along Germantown Avenue. Even at the Arboretum where care is given to provide sufficient space for plants to develop, it is found that thinning often becomes necessary after five or ten years. To accommodate the Rhododendrons that have to be moved, and those now ready to leave the nurseries, an extension of the large bed has been prepared over the past year.

First a large Norway Maple growing in the area of extension was cut down and the stump poisoned. The foliage was too dense and the surface roots too voracious to justify leaving it. The soil was then enriched to a depth of two feet with leaf mold, German peat moss, Michigan peat, and a small amount of manure. After a year of settling, the bed was ready for planting this autumn.

To provide variety of texture and ultimate shade, four Canadian Hemlocks were then planted. These will serve as a background for the Rhododendrons moved in from the old section as well as for two new groups. One of the newly established groups is a collection of unusual Rhododendron species grown from seed obtained from the Royal Botanic Gardens in Edinburgh. These will ultimately range in size from one foot *(R. pemokoense)* to twenty-five feet *(R. vernicosum),* their variation in flower size and color being equally great. One species in particular, *R. dicroanthum,* has shown great promise in the nursery. It boasts a low, mounded habit, exceptionally clean neat foliage, and lovely salmon-red flowers, reminiscent of some of Mr. Charles Dexter's hybrids.

The other new group consists of the first selections of Dr. Henry Skinner's broad-leaved Rhododendron crosses, made in the late 1940's. The parents were carefully chosen, many being *Fortunei* hybrids, and we hope that the progeny will profit from such "aristocratic blood."

M. H. S.

# Notes on the Geology and Ecology of the Morris Arboretum

Edgar T. Wherry

The 175-acre tract comprised in the Morris Arboretum is underlain by varied geological formations, and furnishes a number of habitats for growing plants of differing ecological relationships. On the accompanying map (Fig. 21.) the areas occupied by the three principal rock types are shown.

In the southern strip, marked by a pattern of dots, the underlying formation is Baltimore gneiss. This is a crystalline rock with light and dark minerals in alternating layers, yielding a banded appearance. The chief light minerals are feldspar and quartz, the dark ones micas and amphiboles. Locally these minerals have been so metamorphosed that the rock has changed to a mylonite, with blebs and streaks of feldspar in a dull gray ground-mass so fine-grained that the individual mineral constituents cannot be distinguished.

Under the influence of weathering agencies the Baltimore gneiss gives rise to a buff-colored clayey soil—known technically as the Chester loam. Owing to abundance of feldspar and mica, this soil is fairly high in potassium, but as phosphorus-bearing minerals are small in amount, it is rather low in that element. In reaction it tends to become moderately acid, although not sufficiently so to inhibit seriously the activities of nitrogen-fixing micro-organisms, and so contains adequate amounts of this, the third major nutrient element. The minor elements, calcium, magnesium, and iron, are present in several of the rock-minerals.

The medial ridge, on which the Morris residence stands, is underlain by a stratified rock of Lower Cambrian age, termed in reference to its striking development in a cliff on the Susquehanna River, the Chickies quartzite. This was originally deposited as sandy strata in a shallow inland sea extending northeastward from the Gulf of Mexico region during early Cambrian time. These sand beds were subsequently buried under vast thicknesses of other formations, and circulating waters deposited silica in the interspaces between the grains, forming a hard, impervious rock. Clay originally mingled with the sand grains was metamorphosed to fine-grained mica, and iron compounds to massive-crystalline hematite.

Ultimately the Appalachian revolution took place, uplifting and folding the originally horizon-



Fig. 20. Quartzite cliff along the Wissahickon Creek.




Fig. 21. Geological formations at the Arboretum.

MAP PREPARED BY MARTHA H. STARR

tal strata. In our area the Chickies quartzite beds were uplifted to a vertical position, as can be seen in the cliff jutting out into the Wissahickon Creek. (Fig. 20.)* Subsequent erosion has removed vast amounts of these and other strata, but so resistant is the quartzite that it forms the dominating ridge of the Arboretum tract.

Chickies quartzite weathers gradually to a yellowish gray soil containing numerous silica chips, known technically as the DeKalb sandy loam. From the standpoint of plant nutrition this is a relatively poor, sterile soil. The mica yields a fair amount of potassium, but phosphorus minerals are so sparsely present in the rock that there is a marked deficiency of this element. Minerals containing readily available bases being also lacking, in the course of weathering and soil development a relatively high degree of acidity builds up. This tends to suppress the growth of nitrogen-fixing micro-organisms, and the De Kalb soil is correspondingly low in nitrogen content.

The northern portion of the Arboretum tract is underlain by a third geological formation: magnesian limestone termed from its prominence near a village in eastern Pennsylvania the Leithsville formation. This too is of Lower Cambrian age, and was deposited in the same inland sea as the Chickies, but under different conditions. Instead of sand, the streams now brought into the sea suspensions of mud, and dissolved calcium compounds. Large quantities of calcium together with some magnesium precipitated out of the sea water, forming strata which in time hardened up into limestone. The Appalachian revolution uplifted and folded these beds, raising them far above sea level, and exposing them to erosion. Being relatively soluble, the upper portions were soon removed, and the Whitemarsh valley, of which our northern extension is a part, was formed.

In the course of weathering, the clay originally deposited admixed with calcium carbonate was set free, forming a deep brown soil termed by specialists the Hagerstown loam. To this soil the clay has contributed abundant potassium; and organisms living in the sea concentrated phosphorus, which became disseminated through the limestone and has accumulated in the soil. Any soil acids which tend to form on weathering are soon neutralized by the excess calcium carbonate, so nitrogen-fixing micro-organisms flourish and add this third major nutrient.

Mention may be made of one minor feature with geological if not horticultural interest. Along with the calcium and magnesium there was deposited a certain amount of iron, which on weathering tends to collect in pockets and caverns, in the form of limonite or "bog-iron ore." During the 19th century such material was mined and used as a source of iron at several places in the Whitemarsh valley. On the limestone plateau toward the north border of the Arboretum tract there is a pit representing one of these former mines. All workable ore was long ago removed, however, and the digging is now largely filled with debris and overgrown with shrubs and trees.

Superimposed on these several rock formations lies alluvium deposited by the Wissahickon Creek during overflows which recur year after year. Its water is well charged with both mud and nutrients eroded from headwater fields, and the soil is correspondingly the richest on the Arboretum tract. The fact that it is subject to periodic inundation, however, makes it unsuitable for extensive ornamental plantings.

### Ecological Considerations

By adjusting local conditions, horticulturists can grow practically every desired plant at almost any spot on the earth's surface. The more the natural environment has to be changed, however, the greater the expense and the less the permanence of the plantings. Manifestly a minimum of expense and a maximum of permanence will result from collaborating with Nature, and locating plantings in situations which the species will choose when engaged in its "struggle for existence."

The Morris Arboretum is fortunate in having within its boundaries extensive areas of both acid and of neutral (or at any rate circumneutral) soil, occupying the outcrops of quartzite and limestone respectively. Observations in places which have been but little disturbed by man, both on our grounds and in the general neighborhood, indicate that native species have indeed shown preferences for one or the other type of soil.

In primeval times the acid soil of the hills was occupied by forest in which representatives of the red-oak subgenus were dominant, with an understory including dogwood, azalea, and blueberry. On the steep slope toward the Creek this was replaced by (and today exhibits) a grouping of hemlock, chestnut-oak, and sweet birch. By way of contrast, the neutral soil of the limestone plateau supported a forest in which elms, walnuts, hickories, and members of the white-oak group were prominent. On the alluvial terrace grew a still different assemblage, — river-birch, tulip-tree, sycamore, and box-elder, with spice-bush as understory.

Now that these soil contrasts are recognized, future plantings at the Arboretum can be guided thereby. Of course, when an individual tree or lesser plant is first set out, the nutrients in its "ball-of-earth" and those made available by the disturbance of the soil involved in digging the hole

* Photograph by Dr. Ernst J. Schreiner.

to receive it, may lead to its growing well at the start, no matter into what habitat it is placed. When these nutrients are exhausted, however, it can be expected to grow to normal maturity only if located where the conditions are suitable to its needs.

This matter will soon have to receive attention, for example, in the development of the Michaux Quercetum now being undertaken. Of ten common species of oaks of the middle Atlantic States, acid soils are selected by *Q. coccinea, phellos, prinus, rubra,* and *velutina;* neutral soils by *Q. alba, bicolor, imbricaria, macrocarpa,* and *Muehlenbergii.* These and others for which data are available can be assigned to permanent locations on the respective kinds of soils. For species received without information as to their preferences, it will be desirable to make small plantings in both soil areas, and judge by the way in which the trees respond whether their requirements have been met.

# CEDRELA SINENSIS

HUI-LIN LI

Although *Cedrela sinensis* was introduced into the United States in 1862, it has not been widely planted. A highly commendable tree in many respects, it is eminently worthy of more extensive cultivation. As an ornamental subject, it is stately and well shaped, with large pinnately compound leaves producing a distinctly tropical effect in the landscape. It is fast growing and free of insect pests. As a shade tree, it has already proved its merit in some of the streets in Philadelphia. Since the wood is of excellent quality, especially suitable for furniture making, it is also of great value as a timber tree.

*Cedrela sinensis* is a deciduous tree about 60 feet tall, with shredded bark, a usually straight trunk, and a well shaped rounded and dense habit. It has long pinnately compound leaves with 10-22 leaflets. The leaves vary greatly in size and in the number of leaflets. The margins of the leaflets vary from entire to remotely serrulate. The flowers are small, whitish, and more or less fragrant, produced in large drooping panicles. The fruits are small oval-shaped capsules splitting open when mature and freeing the many winged seeds.

Cedrela thrives best in rich loamy lime soils, but grows also in other diverse soil conditions. It can be propagated by seeds and also sprouts readily from the trunk and roots.

The genus *Cedrela,* which belongs to the Meliaceae or Mahogany Family, contains some 20 species occurring in the tropical regions of America and the Old World. *Cedrela sinensis* is a native of China and one of the only two species of the genus that grow in temperate regions. In China it is of very wide distribution and is also commonly planted. It is a variable species with several recognized varieties. In cultivation it is hardy in Europe and in North America as far north as Massachusetts. The other temperate species of the genus, *Cedrela Rehderiana,* is of local occurrence in southwestern China and has not been introduced into cultivation (4).

Most authors follow C. deCandolle (1, 2) in including the Asiatic species in the genus *Cedrela* instead of placing them in a separate genus *Toona* as done by Harms (3) and a few others. The species of the Old and the New World are so close to each other that generic segregation is scarcely warranted. There is also no striking difference in anatomical characters and the woods have the same general texture and appearance and the same characteristic odor.

The wood of all species of Cedrela is fine-grained, and many of the tropical species yield excellent timber well known for its high quality. Mahogany of tropical America is normally the wood of *Swietenia,* also a member of the Meliaceae, but sometimes wood of other genera of this family is also used. The fragrant wood of *Cedrela odorata* of the West Indies is extensively employed in the making of cigar boxes. It is said that the aroma of the wood improves the flavor of the tobacco. *Cedrela sinensis* has a wood of similar fine quality. It is finely grained, yellow-brown in color and beautifully banded with red. The fresh bark and wood



Fig. 22. *Cedrela sinensis,* Andorra Nursery.



Fig. 23. *Cedrela sinensis,* Andorra Nursery.

have a distinct odor not dissimilar to that of *Cedrela odorata* but to some the smell is somewhat onion-like. In China, the wood is used for high grade furniture, ship building and interior finish, and is known to foreign residents there as "Chinese Mahogany." As the only tree of temperate regions yielding wood of such fine quality, its possibilities as a timber tree in many countries deserve careful exploitation by the forester.

In China, the young shoots of this tree are gathered in early spring and cooked or pickled as a highly esteemed vegetable. The tender leaves are sometimes reddish and slightly fragrant. The trees are often planted around the house for this use and they are often kept low for easy picking of the young shoots.

Around Philadelphia, Cedrela proves to be well adapted and there are many fine trees, planted apparently toward the end of the last century. On the grounds of the Morris Arboretum, a large tree which was cut down in 1936 had 38 annual growth rings, indicating that it was planted around 1898. Since then a grove of stately trees has sprouted from the trunk and the spreading roots of the old tree.

About a mile from the Arboretum, on the grounds of the Andorra Nursery, there is a fine grove of large trees which are apparently 50-60 years of age. They appear to be sprouts from an earlier tree, long since disappeared. The trees are about 60 feet tall. (Fig. 22).* The trunks of these trees are mostly very straight and do not branch until they are about 20 feet from the ground. The larger ones measure 7½ feet in circumference. (Fig. 23).

An avenue lined with fine specimens of Cedrela lies in the Mt. Airy section of the city of Philadelphia along Vernon Road. These and others around that region were originally planted on the grounds of the former Meehan Nursery some sixty years ago, and most probably the old tree of the Morris Arboretum and the trees of the Andorra Nursery all came from the same source. These trees are not as tall as those Andorra trees since they are subject to frequent trimming. The largest specimen has a trunk measuring 7½ feet in girth. Despite the adverse condition of the substratum and the more smoky and sooty air of the city, the trees are mostly of healthy appearance. (Fig. 24.) That they are well adapted for street planting thus seems to be amply proven. The large feathery compound leaves have a tropical effect that proves to be a pleasant variation from the much planted plane tree of the surrounding streets.

That such a valuable tree as Cedrela has received relatively little attention in the past is probably partly due to its close similarity in general appearance to the ubiquitous Ailanthus. The latter is the commonest spontaneous tree in many urban environments in both Europe and North America, sometimes the only tree which flourishes under such conditions. It crops up everywhere, and when cut down, sprouts rapidly, forming a dense, screen-like growth. It becomes in many places a very un-



Fig. 24. *Cedrela sinensis,* Vernon Road, Mt. Airy, Philadelphia.

* Photographs by Dr. J. W. Wright.

desirable weed. Cedrela, because of its similar appearance, is often confused with Ailanthus by the casual observer and thus left unnoticed.

Actually Cedrela has all the desirable but none of the undesirable qualities of Ailanthus plus additional meritorious features of its own. Both trees are hardy, vigorous growers, nearly free from pests. Both sprout readily from the trunk or roots, but Cedrela does not spread like a weed. Ailanthus, which is dioecious or polygamous, has male flowers that produce a disagreeable odor and the pollen is said to be irritating to the respiratory tracts of some people. The flowers of Cedrela, which are perfect, are slightly fragrant. The foliage of Ailanthus also exhales a disagreeable odor when bruised. The wood of Ailanthus is of poor quality, being light and brittle and easily broken, while that of Cedrela is of very fine quality. Branches of Ailanthus often split in wind and storm, but the branches of Cedrela are sturdy and strong and do not break easily. Although the two trees are of similar general appearance, Cedrela is of more regular and dense growth and hence more ornamental. It is also a more long-lived tree.

The two trees can be distinguished easily by their foliage. The leaflets of Ailanthus are readily identified by the 2-4 coarse teeth near the base, each bearing a large gland beneath. The leaflets of Cedrela, which are remotely and slightly serrulate or almost entire, do not bear such glandular teeth. (Fig. 25.) When in fruit, Ailanthus is readily distinguished by the winged samara, while the fruits of Cedrela are woody capsules.

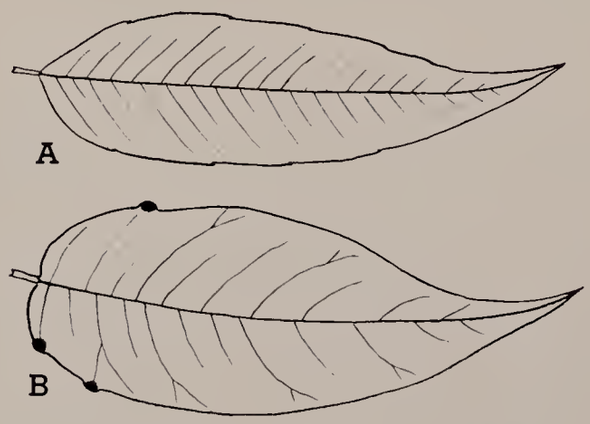



Fig. 25. Leaflets of: A. *Cedrela sinensis;* B. *Ailanthus altissima.*

The common Ailanthus is *Ailanthus altissima,* sometimes known as *A. glandulosa.* It is also a native of China and a common and widely distributed tree there. It is commonly though erroneously called the Tree of Heaven. This name was originally intended for a tropical Malayan species of the same genus, *A. moluccana,* because of its exceedingly tall habit.

Ailanthus, though undesirable in many respects, has large pinnately compound foliage which is useful in creating tropical effects. The tree, fully developed within a few years, usually has a shapely rounded form. It is easily propagated by seeds or root cuttings. These characters, together with its ability to withstand very unfavorable conditions where other trees cannot be used, show that this tree is not entirely valueless.

The two trees, Cedrela and Ailanthus, not only resemble each other in foliage and general appearance, but they are also botanically related. Although Cedrela belongs to the Meliaceae and Ailanthus to the Simarubaceae, these two families are phylogenetically very close to each other. The resemblance of the two genera in question is so close that once the botanist Carrière was misled in describing *Cedrela sinensis* as a species of Ailanthus.

Both Cedrela and Ailanthus have long been cultivated in their native country, China, where in some parts of the country Ailanthus is used for raising wild silkworms. The Chinese have long recognized their close relationships. The classical name of Cedrela is *Chuen* or "Springtree." It is commonly called *Hsiang chuen* or "Fragrant Spring-tree." Ailanthus is colloquially called *Chu chuen* or "Stinking Spring-tree." The classical name of Ailanthus is *Shu* or "Cloud-tree." Because of the poor quality of the wood, *Shu* becomes a metaphor for a "useless person." On the other hand, because of its long and durable life, *Chuen* or Cedrela is used as a literary figure of speech for "father," most respected and venerable in the Chinese way of life.

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# A Progress Report on the Michaux Quercetum

Hui-Lin Li

In a previous article in this Bulletin (Vol. 5: 54-57, 1954), Drs. J. R. Schramm and E. J. Schreiner outlined the aims, general plan and procedure of the Michaux Quercetum, a joint project of the Morris Arboretum of the University of Pennsylvania and the Northeastern Forest Experiment Station of the Forest Service, U. S. Department of Agriculture, financed in part by the Michaux Fund of the American Philosophical Society.

Active work of the project began in the spring of 1953. As reported by Drs. Schramm and Schreiner, by the end of the first season (1953), 29 botanists and personnel of the U. S. Forest Service had sent in a total of 150 separate acorn collections representing 37 species and 23 states. Continued collecting in 1954-55 has brought in to date 240 additional seed collections, amounting to 40 species and 9 varieties from America and four foreign species. The number of states represented now amounts to 33 in the United States plus Quebec, Canada. The number of individual botanists collaborating now totals 45 in addition to 41 persons belonging to 14 different Forest Service stations.

The list of species of oaks now represented covers practically all the common ones of this country, with a fair representation of each from different locations within its geographical range. A number of these species needs further collecting in order to have a wider geographical representation. The assistance of collaborators is also solicited for locating and collecting the as yet unrepresented species of rarer occurrences. A list of the species and varieties of North America, together with their geographical collections now represented in the Michaux Quercetum, is appended herewith.

Efforts were made during the last year to extend the area of collecting to Europe and Asia. Contacts were made with botanists and foresters in many different countries in Europe by Dr. Schramm. So far the response has been very favorable and we expect to receive in the next two years collections from these various foreign sources and also from Asia.

Up to the present, about 26,000 seeds have been planted. Since the average germination of all lots for the past two years came to about 60% (aside from 1,400 seeds planted this year), about 14,500 seedlings germinated. Aside from seedlings taken for herbarium specimens, and those which winter-killed or perished because of transplanting from the seed bed to the nursery, there are about 11,000 young trees and seedlings on hand.

The seedlings are left in the seed bed until the second spring to test for hardiness. The first year seedlings (1953) are now all transferred to the specially prepared nursery. (Fig. 26.) The second year seedlings (1954) are still in the seed bed but will be transplanted to the nursery in the spring of 1956. Altogether 5 rodent-proof seed beds, each measuring 100 feet long and 4 feet wide, were specially constructed for this purpose. The nursery space now taken up by these oak seedlings amounts to 34,000 square feet.

Observations made in 1954 and 1955 show that germination takes place from late April to early June. By the first week of June, about 90% of the seedlings are up. In general the earliest to come up are mostly the West Coast species and also the following: *Q. alba, Q. borealis, Q. coccinea, Q. macrocarpa, Q. prinus, Q. Shumardii,* and *Q. velutina.* The earliest of the eastern oaks are *Q. borealis* and *Q. prinus.*

Among the late germinating species are *Q. bicolor, Q. chrysolepis, Q. cinerea, Q. Chapmanii, Q. ellipsoidalis, Q. falcata, Q. ilicifolia, Q. imbricaria, Q. laurifolia, Q. lyrata, Q. marilandica, Q. myrtifolia, Q. Nuttallii, Q. nigra, Q. palustris, Q. prinoides, Q. phellos, Q. stellata* and *Q. virginiana.* The evergreen species are especially tardy. In the last two years some of the above mentioned species like *Q. Chapmanii, Q. laurifolia, Q. myrtifolia* and *Q. virginiana* did not start to germinate until the end of May or early June, with the result that



Fig. 26. Nursery of the Michaux Quercetum.

many of the seedlings were burned off at the ground level by the hot sun.

A preliminary analysis of the measurements on rate of growth taken during the growing seasons show that there are significant differences due to geographical origin of the parent trees of the same species. There is also evidence in some cases that there is a possible correlation between the growth rate of the seedlings and the latitudinal site of the parent tree. This may be due to an inherited photoperiodic effect or racial vigor.

The seedlings of 1953, now outplanted in the nursery, are recorded for their mortality and die-back. The mortality is largely due to winter-killing, although the effect of transplanting should also be counted. However, this effect seems to be negligible. The mortality rate of nearly all species collected from the eastern and northern states is, as might be expected, very low, ranging from 0 to about 10%, averaging about 5%. Death due to transplanting or drought, etc. therefore cannot exceed this figure. However, species from outlying areas present a very different picture. The species from the West Coast are listed in the following table:

| State | Species | Mortality |
|---|---|---|
| California | *Q. agrifolia* | 94% |
| | *Q. chrysolepis* | 88% |
| | *Q. Douglasii* | 44% |
| | *Q. dumosa* | 47% |
| | *Q. d.,* var. *bullata* | 90% |
| | *Q. Garryana* | 36% |
| | *Q. Kelloggii* | 30% |
| | *Q. lobata* | 37% |
| | *Q. myrtifolia* | 72% |
| | *Q. Wislizenii* | 60% |
| Oregon | *Q. Kelloggii* | 18% |
| Washington | *Q. Garryana* | 20% |

Nearly all the survivals of these species suffered from considerable winter die-back. It is to be expected that the mortality rate will be further increased after the second winter. On the other hand, among the plants from the northeastern states, not only is the mortality rate either very low or non-existent, but practically no winter die-back is observed.

From the above table, it is interesting to note that the two species from California that have the lowest mortality rate, *Q. Kelloggii* and *Q. Garryana,* are species of wider ranges that extend also to the northern states, and these same species from Washington or Oregon show a considerably lower mortality rate than those from California.

More or less similar results are noted from other areas such as Texas, Florida, etc. These preliminary comments will be verified and extended by further observation on additional collections covering wider ranges from the second year's crop.

A list of native species and varieties represented in the Michaux Quercetum, 1955:

1. *Q. agrifolia* Neé Calif.
2. *Q. alba* L. Quebec, N. H., Mass., N. Y., Pa., N. J., Md., Va., N. C., Mich., Wisc., Ill., Tenn., Ark., Tex.
3. *Q. bicolor* Willd. Mich., Ill.
4. *Q. borealis* Michx. f. (*Q. rubra* auct. non L.) N. H., Mass., N. Y., Pa., N. J., N. C., W. Va., Tenn., Mich., Ill.

4a. *Q. borealis,* var. *maxima* (Marsh.) Ashe Quebec, N. H., Ill., Kan.

5. *Q. Chapmanii* Sarg. Fla.
6. *Q. chrysolepis* Liebm. Ore., Calif.

6a. *Q. chrysolepis,* var. *vaccinifolia* (Kell.) Engelm. Calif.

6b. *Q. chrysolepis,* var. *Palmeri* (Engelm.) Sarg. Calif.

6c. *Q. chrysolepis,* var. *nana* (Jepson) Jepson Calif.

7. *Q. coccinea* Muench. Va., Tenn., N. C., Ala., Ill.
8. *Q. Douglasii* Hook. & Arn. Calif.
9. *Q. dumosa* Nutt. Calif.

9a. *Q. dumosa,* var. *turbinella* (Greene) Jepson Calif., Ariz.

9b. *Q. dumosa,* var. *bullata* Engelm. (*Q. durata* Jepson) Calif.

10. *Q. ellipsoidalis* Hill Minn.
11. *Q. falcata* Michx. N. J., Md., Va., Ala., Ill., Ark.
12. *Q. Gambellii* Nutt. Colo., Utah, Ariz.
13. *Q. Garryana* Dougl. ex Hook. Wash., Ore., Calif.
14. *Q. grisea* Lieb. Ariz.
15. *Q. ilicifolia* Wang. Conn., Pa., N. J., W. Va., Va.
16. *Q. imbricaria* Michx. Ohio, Ind., Ill.
17. *Q. incana* Batr. (*Q. cinerea* Michx.) Tex.
18. *Q. Kelloggii* Newb. Ore., Calif.
19. *Q. laevis* Walt. Fla.
20. *Q. laurifolia* Michx. (*Q. obtusa* (Willd.) Ashe) S. C., Fla., Ark.
21. *Q. lobata* Neé Calif.
22. *Q. lyrata* Walt. Miss., Ark., Tex.
23. *Q. macrocarpa* Michx. Minn., S. D., Kan.

24. *Q. marilandica* Muench. N. J., Ill., Kan., Ark., Tex.
25. *Q. Michauxii* Nutt. (*Q. prinus* auct. non L.) S. C.
26. *Q. Muhlenbergii* Engelm. Va., Kan.
27. *Q. myrtifolia* Willd. Fla.
28. *Q. nigra* L., Md., Va., Miss., Ark.
29. *Q. Nuttallii* Palmer. Miss.
30. *Q. palustris* Muench. Pa., Ohio, Ill.
31. *Q. phellos* L. N. J., Md., Va., S. C., Miss., Ark.
32. *Q. prinoides* Willd. Kan.
33. *Q. prinus* L. Mass., Conn., Pa., N. J., Md., Va., Ohio
34. *Q. pumila* Walt. Fla.
35. *Q. Sadleriana* R. Br. Calif.
36. *Q. Shumardii* Buckl. Ill., Tenn., Miss., Fla.

36a. *Q. Shumardii,* var. *Schneckii* (Britt.) Sarg. Tenn.

37. *Q. stellata* Wang. Conn., Md., Ill., Tenn., Mo., Ark.

37a. *Q. stellata,* var. *Margaretta* (Ashe) Sarg. Fla.

38. *Q. velutina* Lam. Mass., Conn., Va., N. C., Tenn., Ala., Mo., Mich., Minn., Ill., Ark.
39. *Q. virginiana* Mill. Va., S. C., Fla.
40. *Q. Wislizenii* A. DC. Calif.

40a. *Q. Wislizenii,* var. *frutescens* Engelm. Calif.

Collaborators contributing seeds in 1954-55:

Ahles, Harry E., University of Illinois

Aird, Paul L., Industrial Cellulose Research Ltd., Canada

Baldwin, J. T., Jr., College of William and Mary

Bassiotis, C., Greece

Brown, Russell G., University of Maryland

Buell, M. F., Rutgers University

Daphis, Sp., Greece

Detling, LeRoy E., Oregon State College

Fogg, J. M., Jr., Morris Arboretum

Hammond, H. David, Morris Arboretum

Li, Hui-Lin, Morris Arboretum

Massey, A. B., Virginia Polytechnic Institute

Pauley, Scott S., Cabot Foundation, Harvard University

Perdue, Robert E., Texas Research Foundation

Reeder, John R., Yale University

Santamour, Frank S., Harvard Forest

Schramm, J. R., Morris Arboretum

Small, John A., Rutgers University

Tucker, J. M., University of California, Davis

Vernon, C. C., Downey, California

West, Erdman, Florida Agricultural Experiment Station

White, O. E., Blandy Experimental Farm, University of Virginia

Zobel, Bruce, Texas Forest Service

U. S. Department of Agriculture, Forest Service

California Forest and Range Experiment Station
- Carpenter, Jack
- Graham, Charles E.
- Colwell, E. L., Jr.
- Hellmers, Henry
- Meyer, Jewell L.
- Roy, D. F.

Central States Forest Experiment Station
- Deitschman, G.
- Roach, B. A.
- Rogers, Nelson F.
- Vinton Furnace Experimental Forest

Lake States Forest Experiment Station
- Arend, J. L.
- Boughner, Wm.
- Roe, Eugene L.
- Scholz, Harold
- Watt, Dick
- Westing, Arthur H.

National Forest Region 7
- Hanlon, P. J.

Northeastern Forest Experiment Station
- Church, Thomas W.
- Gabriel, W. J.
- LeVoy, Gerald C.
- Lindahl, Robert R.
- Schreiner, E. J.
- Wright, J. H.

Pacific Northwest Forest and Range Experiment Station
- Gratkowski, H.
- Koenig, R. C.
- Stein, William I.

Southeastern Forest & Range Experiment Station
- Green, Walter E.
- Jarrett, Tim
- LeGrande, William P., Jr.

Southern Forest and Range Experiment Station
- Hebb, E. A.

# GIFT TO THE LIBRARY

It is a pleasure to acknowledge here the handsome gift of Mr. Albert F. Meehan who has recently donated to the Library of the Arboretum bound sets of Gardner's Monthly, Vol. I, 1859, to Vol. XXIX, 1887, and Meehan's Monthly, Vol. I-IV (1891-1894, VI-VII (1896-97) and XI (1901).

Gardener's Monthly, "Devoted to Horticulture, Arboriculture, Botany and Rural Affairs," was edited by Mr. Meehan's grandfather, Thomas Meehan, well-known horticulturist and botanist and founder of the Germantown Nurseries, later known as Meehan's Nurseries. As one of the foremost horticultural publications of its day, Gardener's Monthly numbered among its contributors the leading horticulturists in America. It therefore constitutes today a valuable historical record of horticultural ideas and practices during the second half of the last century.

Publication of Gardener's Monthly ceased with the death of its publishers, but in 1891 Thomas Meehan began publishing Meehan's Monthly, which he designated as "A Magazine of Horticulture, Botany and Kindred Subjects." Publication was continued after his death in 1901 by one of his sons, S. Mendelson Meehan.

These two publications, replete with valuable horticultural information, are important additions to our list of periodicals and will be greatly appreciated and much used by those who consult our Library. We are indeed indebted to Mr. Meehan for his kindness.

A future number of this Bulletin will contain an article on the Library of the Morris Arboretum.

J. L. B.

# DR. WHERRY'S BOOK ON PHLOX

Under the official publication date of November 18, 1955, there appeared Volume III of the Morris Arboretum Monographs: *The Genus Phlox,* by Dr. Edgar T. Wherry, Professor of Botany, Emeritus, of the University of Pennsylvania and for many years a member of the Scientific Staff of the Morris Arboretum.[1]

For more than a quarter of a century Dr. Wherry has been an acknowledged authority on this essentially American genus of plants, and the present long-awaited volume, which embodies his careful observations in the field and in the herbarium, will be enthusiastically received by botanists and flower-lovers throughout this country and abroad.

The genus *Phlox,* as here treated, includes 67 species, 84 subspecies and a number of minor variants. The work is copiously illustrated with the author's excellent photographs and a series of line-drawings and range-maps prepared by Dr. Hui-Lin Li, a member of the Staff of the Morris Arboretum.

In addition to the purely descriptive material, the author has provided a full set of keys to the sections, subsections, species and subspecies. The geographic origin and evolutionary relationships within the genus are discussed and suggestions concerning desirable horticultural forms are offered.

The volume is priced at $4.00 per copy, but is available to Associates of the Morris Arboretum at the special rate of $3.00.

J. M. F., Jr.

[1]The other volumes in this series of Monographs published by the Associates of the Morris Arboretum are:
*The Beginnings of Plant Hybridization* by Conway Zirkle, 1935.
*Conservation of Renewable Natural Resources* —University of Pennsylvania Bicentennial Symposium, 1941.

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*Flowers of Evodia Daniellii*

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## ARBORETUM ACTIVITIES

### PAVING OF ROADWAYS

During the early winter approximately 1,000 feet of service roads in the Arboretum were hard-surfaced. Two sections were done at this time: one running from the Gate House on Hillcrest Avenue to the stream near the log cabin, the other extending from the corner of Hillcrest and Germantown Avenues down along the west side of the Arboretum to the lilac planting. Both of these sections were subject to bad washouts at times of heavy rain and the new hard surfaces will result in a great saving of time and labor formerly required to repair the roadbeds following severe storms. They will also make it appreciably easier to walk along these roads which were formerly surfaced only with loose stones and gravel.

### NEW WOODS TRAILS

One of the most attractive sections of the Arboretum, the wooded slope along the Wissahickon, has been largely inaccessible because of the dense growth of underbrush and the steepness of the grade. This winter a series of trails has been laid out, graded and in places protected by logs. It is now possible for visitors to walk along the creek and to wander up and down the slope, enjoying the beauty of the only naturally wooded area within the Arboretum.

*(Continued on page 15)*

# A Horticultural and Botanical History of Ginkgo

Hui-Lin Li

## Introduction

No plant more than Ginkgo has a stronger claim to be called a "living fossil," a term used by Darwin to designate survivals of the past. This very same tree was thriving a hundred and a quarter million years ago when Dinosaurs were still roaming the earth, and the genus has remained from that time until now almost unchanged. Its ancestry traces back for another hundred million years to the later part of the Permian period in late Paleozoic. These ancestral and related plants were most abundant during the Upper Triassic and the Rhaetic-Jurassic ages in the early Mesozoic. Thus the sole living member of a once great and dominant race of the vegetation of the world, the Ginkgo is, among all the tens of thousands of plant species existing today, a most precious and tenuous link between the present and the remote past.

From its last natural refuge in the mountains of eastern China, Ginkgo has now spread through cultivation to many parts of the world. With the aid of man, it now reinhabits grounds lost to nature during the last million years. It thrives even in a modern urban environment which many other trees cannot tolerate. It defies the scourge of all pests. A tree that survives the vicissitudes of a hundred million years must have come from a most tenacious stock and have been specially selected by mother nature out of thousands of similar and dissimilar plants of the same age.

Ginkgo, with its spreading rigidly ramified branches and curiously shaped leaves, is a tree of great distinction and dignity in appearance. Human history appears insignificant when compared with the genealogy of this tree which now stands in the gardens and along city streets created by man who appeared millions of years later. As an eminent paleobotanist, the late Sir Albert Seward (1938), in discussing its geological history, remarks: "It appeals to the historic soul: we see it as an emblem of changelessness, a heritage from worlds too remote for our human intelligence to grasp, a tree which has in its keeping the secrets of the immeasureable past."

Ginkgo survives as a living plant in China only. Although there is a great mass of writings on this tree in the western languages, it does not seem that the history of its origin and cultivation in the Orient has ever been properly investigated. There are the often repeated but somewhat misinformed statements that Ginkgo has been in cultivation in China since very ancient times, that its origin is entirely unknown, and that it is preserved in cultivation only by Buddhist monks on monastery grounds.

This paper reviews briefly the horticultural and botanical history of the plant, its historical and geographical origins, early cultivation in China, subsequent introduction into Japan and the western world, botanical investigations made on the plant, and problems pertaining to its scientific name.

## Origin in China

Ginkgo is unknown to the ancient Chinese; its records in the literature cannot be traced definitely beyond one thousand years. The earliest Chinese civilization prospered along the Yellow River valley in northern China. Many plants have been domesticated there since time immemorial; these as well as numerous wild plants are recorded in the earliest classics and other writings of three thousand years or more ago. Among the earliest domesticated trees are the Peach and Apricot; the wild ancestors of the former have long since disappeared. Numerous other trees like Pines, Arborvitae, Juniper, Jujube, etc. are mentioned in this ancient literature, trees that are still native to northern China. But Ginkgo is conspicuously absent, attesting to the fact that it was not a native tree of that region in ancient times, although at present it occasionally occurs there as a cultivated species.

Before the Sung dynasty, in the late 10th century, Ginkgo was almost unknown in northern China. It first appeared in literature in the early Sung in the 11th century as a plant native to eastern China, south of theYangtze River. During the Sung dynasty, the Yangtze River valley became more and more developed and more closely integrated with the north. Because of pressure exerted by the invading Chin Tartars from the north, there was a gradual southern movement of culture and population. This movement was particularly intensified around 1127 A. D., when the capital was moved from Kaifeng in northern central China to Nanking and finally to Hangchow in eastern China south of the Yangtze River. Before this, the period is known as the Northern Sung (960-1127 A. D. ) and from then on until the end of the dynasty, when the Mongols conquered the whole of China and established the Yuan dynasty, as the Southern Sung (1128-1279 A.D.).

## Earliest Records

In the 11th century, Ginkgo, when it first appeared in the literature, was known as a plant of the region south of the Yangtze River in eastern China. At Kaifeng, the capital, it was considered as a rare and precious "fruit." It was sent as tribute yearly from its native region to the capital to be presented to the Emperor. Subsequently a few trees were planted in the capital and this is the first recorded instance of cultivation outside of its natural range. Gradually it became more commonly grown and its cultivation also spread to other regions.

Previous to the Sung dynasty literature, there are only a few alleged but unproven references to Ginkgo. In a poetical essay, entitled Wu Tu Fu, on the capital of the Wu Kingdom, by Tso Ssu of the Tsin dynasty (265-420 A. D.), there is mention of a fruit called P'ing Chung Kuo. The Wu Kingdom is modern Kiangsu and Anhwei provinces, the native haunt of Ginkgo. A later commentator noted that the fruit is of a silvery color. For this reason, herbalists and botanists of subsequent ages such as Li Shih-chen in 1596, and Wu Chi-chun in 1848, suggest that this might be referrable to Ginkgo but none of these authors claims it as provable.

Ginkgo is also mentioned in a work called Chung Shu Shu, Book on the Culture of Trees, a small volume on agriculture attributed to the famous gardner Kuo To Tu or Kuo the Hunchback of the 8th century. However, this is actually a work of much later origin, probably of the Yuan dynasty around the 14th century. That Ginkgo is mentioned in this work as Yin Hsing, Silver Apricot, a name apparently not in use earlier than the late 11th century, indicates its much later origin.

In another instance Ginkgo is possibly meant in a story attributed to a T'ang poet in a Sung note book. Thus Ginkgo might have been known to the northern Chinese before the Sung dynasty, but it was apparently a very rare plant not then in cultivation.

## Cultivation in Sung

There are many definite records about this plant in the Sung literature. It was, as mentioned before, first sent as tribute from its native place, mentioned specifically as Suancheng of the Ningkuo District in what is now the southern part of Anhwei province, south of Wuhu, a port along the Yangtze River. In a Sung notebook entitled Shi Hua Chung Kuei, it is said that "In the Capital (Kaifeng), there was originally no Ya Chio (Ginkgo). Since Prince Li Wen-ho came from the south and transplanted it to his residence, it becomes famous. From then it gradually propagates and multiplies, and fruits from the south are no longer considered precious." Prince Li lived in the first half of the 11th century.

In another Sung work entitled Chun Chu Chi Wen, it mentions that "During the reign Yuan Feng (1078-1084) there was a fruit in the capital called Ya Chio Tzu (Ginkgo). There were four big trees producing several bushels of fruits each year."

The name Ya Chio, meaning Duck's Foot, refers to the shape of the leaves. This is evidently the earliest name of the plant, and possibly the name first known in its place of origin. After the nut became known in the capital Kaifeng, another name, Yin Hsing or Silver Apricot, referring to the "fruit" was adopted, and the two names were often used concurrently.

## Ginkgo in Sung Poetry and Paintings

The Sung dynasty is a period of great artistic and literary activity. During this period, Ginkgo was not only first introduced into cultivation, but it also began to appear in poetry and in paintings. It was eulogized by many famous poets, who mostly praised its "fruits" and sometimes also its leaves. Undoubtedly the praise of this rare "fruit" by the many renowned poets brought fame to this plant in northern China.

Among the verses we may mention especially the ones by the famous poets Ou-yang Hsiu and Mei Yao-ch'en because of their historic interest. Ou-yang (1007-1072 A. D.), a famed historian, essayist and poet, was a native of Kiangsi Province. Mei (1002-1060), also a famous poet, was a native of southern Anhwei Province. Both then held official positions in the capital Kaifeng.

Their exchange of poems began when Ou-yang presented Mei with some Ginkgo nuts from the trees of Prince Li mentioned above. This nut, then rare and considered precious in the capital, was familiar to Mei as it was produced in Mei's home region. In expressing his gratitude to Ou-yang he wrote a verse which says that Ya Chio (Duck's Foot) was unfamiliar to the northerners just like walnut to the southerners, and that it was so named because of its leaves. It was produced in Mei's native region, Suancheng. He was thus happy to find it planted in the capital as a rare and precious "fruit" and was sentimental in receiving this as a present since it was originated from his home area.

Ou-Yang was a great historian, and on this occasion he took the opportunity in answering Mei with a poem in which he wished to leave some useful information for posterity. The contents of the verse can be translated simply as thus:

"Ya Chio (Duck's Foot) grows in Kiangnan, with a name which is not appropriate. At first it came in silk bags as a tribute, and as Yin Hsing (Silver Apricot) it became cherished in the middle provinces. The curiosity and effort of the noble Prince [Li] brought roots from afar to bear fruit in the capital. When the trees first fruited they bore only three or four nuts. These were presented to the throne in a golden bowl. The nobility and high ministry did not recognize them and the Emperor bestowed a hundred ounces of gold.

Now, after a few years the trees bear more fruits. The friendly owner presents me with these nuts like giving me pearls. In the past Chang Chien (2nd century B. C.) introduced Grape and Pomegranate [from Central Asia]. We can imagine that when these first came, they must be similarly highly valued as these nuts. But now these plants are common all over China, growing along fences and walls. The very things are still the same, but human nature changes in time. Someone should record the beginning so that future generations can know its origin. This is thus not only continuing your verse, but also contributing to history."

Subsequently they further exchanged poems when Mei returned to his home town and sent the nuts to Ou-yang. In these poems Ou-yang mentioned that Mei's nuts were collected from the forests in the wild and both poets now used the name Yin Hsing or Silver Apricot but not Ya Chio or Duck's Foot.

Ginkgo was the subject of many verses by other poets during the Sung dynasty. It also became a frequent subject for painting. In the Hsuan Ho Hua P'u, Catalogue of Paintings of the Imperial Collection of the reign of Emperor Huei Tsung (reign 1101-1125) there are listed several paintings of this plant. One of them entitled "A picture of Yin Hsing (Silver Apricot) and the bird Pei Tou Wen," was by an artist Yo Shih-hsuan, an official of the reign of Emperor Shen Tsung (1067-1084). Another entry lists two paintings of "A study of Ya Chio (Duck's Foot)" by Prince Tuan Hsien Wang, 4th son of the Emperor Yin Tsung (reign 1063-1066) and brother of Emperor Shen Tsung.

It is interesting to note that the earlier interest in the plant is because of the edible nut and the ornamental features of the plant. The "fruit," of course, is not a true fruit, but a drupe-like seed. It is yellowish when mature, of the size and appearance of a small apricot but has a silvery bloom on the outside, hence the literary name Yin Hsing or Silver Apricot. The inside kernel is edible. This nut is frequently compared with the walnut by Sung poets, a popular nut fruit of the north.

### Ginkgo in Later Dynasties

There are many herbals and materia medicas in the T'ang and Sung dynasties, but none of them mentions Ginkgo. Ginkgo first appeared in the herbals of the Yuan dynasty (1280-1368), in Shih Wu Pen Ts'ao, or Edible Herbal by Li Tung-wan, and Jih Jung Pen Ts'ao or Herbal for Daily Usage by Wu Jui. In Wu's book it is noted that the nuts, if eaten in excess, especially by children, may be slightly poisonous.

Besides the names mentioned, in the Yuan dynasty there were other names in common usage, such as Pei Kuo (White Fruit), Pei Yen (White Eye), Ling Yen (Spirited Eye), Jen Hsing (Nut Apricot), etc. Among these, Pei Kuo or White Fruit is still the most widely used colloquial name throughout the country in modern times, while Yin Hsing or Silver Apricot remains as the common literary name.

Another common name that appeared in later times is Kung Sun Shu or Grandfather-Grandson tree. This attests to the fact that only old trees bear fruit and therefore a tree planted by a man will be useful to his grandson.

The Ginkgo is a dioecious tree, that is, the male and female flowers are borne on separate individuals and hence only the female tree bears fruits. This phenomenon was considered mysterious by the earlier observers. They early noted, however, that there are male and female trees and the two should be planted nearby to insure fruiting, but they also entertained the strange idea that female trees if planted alone by the side of water can also bear fruit.

After the Sung and Yuan dynasties, Ginkgo seems to be widely cultivated all over the country. The Sung and Yuan authors do not mention specifically that the tree occurred only in cultivation including its native habitat, nor is there any association of this tree with religious institutions. The writings of these authors seem to imply that the tree as occurring in southern Anhwei was indigenous. And it has always been the custom of the Buddhist as well as the Taoist priests to preserve portions of the natural forests around their temples, thus preserving many indigenous species which otherwise would have perished in agricultural areas. Thus, venerable specimens are often found on temple grounds, but they occur in many other places as well. Very old trees, Ginkgos as well as many other kinds, are often revered and preserved because of geomantic beliefs and they are sometimes, especially in the remote interior, decorated with incense stands or wayside shrines. It is a kind of primitive nature worship, and the tree is honored because of its age and not its kind. Contrary to the much perpetuated belief, emphatically stated especially by Wilson (1920) and frequently copied by other horticultural writers, the Ginkgo has no association with Buddhism. The cultivation of the Ginkgo tree has no religious origin or significance and its preservation is not attributable to planting by Buddhist or Taoist priests.

Ginkgo is described in detail in the great herbal Pen Ts'ao Kang Mu of 1596 by Li Shih-chen and also in the great botanical work Chih Wu Ming Shih Tu Kao of 1848 by Wu Chi-chun, where a good figure of the foliage and fruit is found.

Li repeatedly says that the Ginkgo originates from Kiangnan, a province of the Ming dynasty embracing the modern provinces Kiangsu and Anhwei. On the name of the plant he says that it was originally called Ya Chio (Duck's Foot) because of the shape of the leaves and that when it was first sent as tribute in the early Sung to the throne, the name was then changed into Yin Hsing

or Silver Apricot because of the whitish "fruit." His description of the plant which was detailed and quite accurate reads:

"Yin Hsing (Silver Apricot) grows in Kiangnan, especially around Suancheng. The tree is twenty to thirty feet high with thin and straight-veined leaves like the web of a duck. The leaf has a notch at top and is green above and palish beneath. The flowers are borne in clusters in the second month and are rarely seen by people. A single branch often bears tens or hundreds of seeds resembling the seeds of Lien (Melia). The seeds become ripe after frost, and the flesh is removed for the nut inside. The nut is pointed at both ends. Those with three ridges are male and two female. The kernel is green when young and later becoming yellow. Male and female trees should be planted nearby to insure fruiting, or the female trees can be planted along water. Another method to insure fruiting is to graft a male branch onto the trunk of a female. . . . . ."

The statement that the number of ridges on the nut can be used to distinguish sexes appears in several other and earlier works. Nuts with three ridges are rare. It seems that there is hardly any truth in this observation.

Ginkgo is now a widely grown ornamental and nut tree in most parts of China. Occasionally it is made into a dwarf tree for pot culture. The kernel is eaten roasted, or sometimes cooked with fowl or meat. There are also certain medicinal effects attributed to the kernel.

### Introduction Into Japan

Ginkgo was introduced from China into Japan at a fairly early date perhaps in the Sung dynasty when the tree first became known in northern China. In Japan there are specimens alleged to be nearly a thousand years old. The tree is known there as Icho and the fruit Ginnan, the former the corruption of the Sung Chinese name Ya Chio (Duck's Foot) and the latter the Chinese Yin Hsing (Silver Apricot). (Koidzumi 1936, Makino 1951).

The exact date of introduction from China to Japan is unknown. Wilson's statement (Wilson 1920) that "the tree reached Japan with Buddhism in the 6th century of the Christian era" is entirely unfounded, as Ginkgo was at that time not even yet known in China. And, as stated elsewhere, the tree has no association with Buddhism whatsoever except incidental planting on temple grounds. It seems to have been carried from southern Kiangsu and Anhwei, the original habitat of the tree, directly to Japan. The Japanese pronunciation of the names of the trees is closer to the Wu dialect of southern Kiangsu than to the northern Mandarian.

Moreover, there is known in Japan a legend about growing a Ginkgo tree from cutting in southern Kiangsu in China. According to the Gazette of Kunshan, a district in southern Kiangsu in China, this is the story of a Ginkgo tree in the Sung dynasty. It is said that when Emperor Kao Tsung moved from Kaifeng in the north to Nanking and Hangchow in the south in 1127, the imperial calvacade crossed the Yangtze River into southern Kiangsu. Coming to a town called Chen I near the city Kunshan between Soochow and Shanghai, an official named Kung I, a native of the northern capital Kaifeng, picked a branch of Ginkgo, sticking it into the ground and prayed that if the branch lived, he would settle there. The branch later developed into a huge tree and in later years the trunk became gnarled and twisted and adorned with many hanging "nipples" as in other venerable trees of this same kind.

In both China and Japan, there are now many specimens of immense size. On very old trees there often develop peculiar burs which are called nipples, "chi-chi" in Japanese. These are due to abnormal development of dormant or adventitious buds. If these hanging burs reach the ground, they take root and bear leaves. (Fujii 1895). Henry (Elwes & Henry 1906) gives a picture of such an old tree in western China which is reproduced here. (Fig. 1).



Fig. 1. A Ginkgo tree in western China. (From Elwes & Henry, Trees of Great Britain and Ireland, 1906)

## Introduction Into the West

Ginkgo was first made known to the western world by Kaempfer, a surgeon in the employ of the Dutch East India Company, who first observed it in Japan in 1690 and published in 1712 a description with a figure of the foliage and fruit (Kaempfer 1712). The tree was first introduced into the Botanic Garden at Utrecht. Jacquin brought it into the Botanic Garden at Vienna sometime after 1768. It was introduced into England about 1754. (Henry 1906).

Most of the earlier trees raised in Europe appear to have been males. The first recorded female tree was one found by DeCandolle near Geneva in 1814. Scions from that tree were grafted upon a male tree in the Botanic Garden at Montpellier, where the first perfect seed is reputed to have been produced.

Ginkgo was first introduced into America in Philadelphia. As far as authentic records go the oldest tree in this country is the one in Woodlands Cemetery, in West Philadelphia, which was introduced by William Hamilton from England in 1784. This is a magnificent specimen of a male tree. Harshberger (Wilson 1920) is of the opinion that the Ginkgo tree in the old Bartram Garden in West Philadelphia is the oldest and the first planted in America because the garden is older than that founded by Hamilton and the tree is larger. Elsewhere in Philadelphia, there are other large specimens scattered over the area. An old tree in Germantown, a male one, has a female branch grafted onto it, leading many to believe that Ginkgo is monoecious. In the Morris Arboretum, the largest tree is a female one, which was planted over seventy years ago, now measuring 7½ feet in girth. This tree has fruited for a number of years and now bears a heavy crop of seeds every season.

The Ginkgo is now probably the most esteemed street tree in this country, especially valued because of its upright habit and freedom from insect pests. It is considerably planted in Philadelphia, Washington, D. C., New York, and many other large cities, especially in the east. It is ironical that the oldest living species of trees is better suited to the most modern man-made habitat than almost any other tree.

## Botanical Investigations

The name Ginkgo was given by Kaempfer. Kaempfer's designation was adopted by Linnaeus, who in 1771, described the plant as *Ginkgo biloba*. In 1797, the English botantist J. E. Smith (1797) considered the name "uncouth and barbarous" and renamed it *Salisburia adiantifolia*. However, the latter name has no nomenclatural standing as personal preference is not a valid reason to reject an older legitimate name.

When Ginkgo was first known to science, it was regarded as one of the conifers and generally included in the Taxaceae. In 1895, the Japanese botanist Hirase (1895-1898) made the startling discovery that the ovules are fertilized by motile sperm-cells conveyed to them by pollen tubes. This differs radically from all other conifers, taxads, and flowering plants which have non-motile male nuclei. Motile sperm-cells are found only in the lower plants and in the Ferns and Cycads. This discovery established definitely the unique isolated nature of Ginkgo which was raised into ordinal rank by Engler.

Hirase's find is often claimed as one of the great discoveries in botany in the 19th century. His discovery, followed by further investigation by other botanists, stimulated many detailed studies on the various interesting features of this most unusual plant.

The Ginkgo is a deciduous tree. The branches are beset with short spur-like shoots which bear clusters of fan-shaped leaves and flowers. The venation in the leaf is open and dichotomous. The male and female flowers are produced on different trees. The male flowers appear in pendulous catkins of numerous loosely arranged stamens. The female flowers arise usually in pairs, each a long stalk with 2 naked ovules. The seed is drupe-like with a fleshy outer covering enclosing a woody shell with a kernel. (Fig. 2).

All these structures and many other interesting details have been intensively studied by many botanists especially the unusual process of fertilization noted above and the nature of the ovule. The ovule bears a collar-like rim at the base, a structure that has given rise to much discussion. (Fujii 1896, Shaw 1908). The development of the seed is also very unusual, as the ovule drops before fertilization and the embryo is formed later in the detached ovule as it lies on the ground during the winter. (Eames 1955). The equally remarkable development of the embryo was first described by Strasburger (1872). The botanical aspects of *Ginkgo biloba* have been monographed by Seward and Gowan (1900) and Sprecher (1907).

The female tree, because of the disagreeable odor of the fleshy covering of the fallen seeds, is less desirable than the male tree in cultivation, especially as street trees. It is claimed that there are some differences in the growth habit of the two sexes, the male trees being more pyramidal and the female more spreading, and that the male trees tend to loose their leaves earlier in the autumn. These characters, however, do not appear to be constant enough to be relied upon. As it takes many years for the trees to flower, it will be highly desirable to devise some way of telling the sexes in young trees. Recent studies have

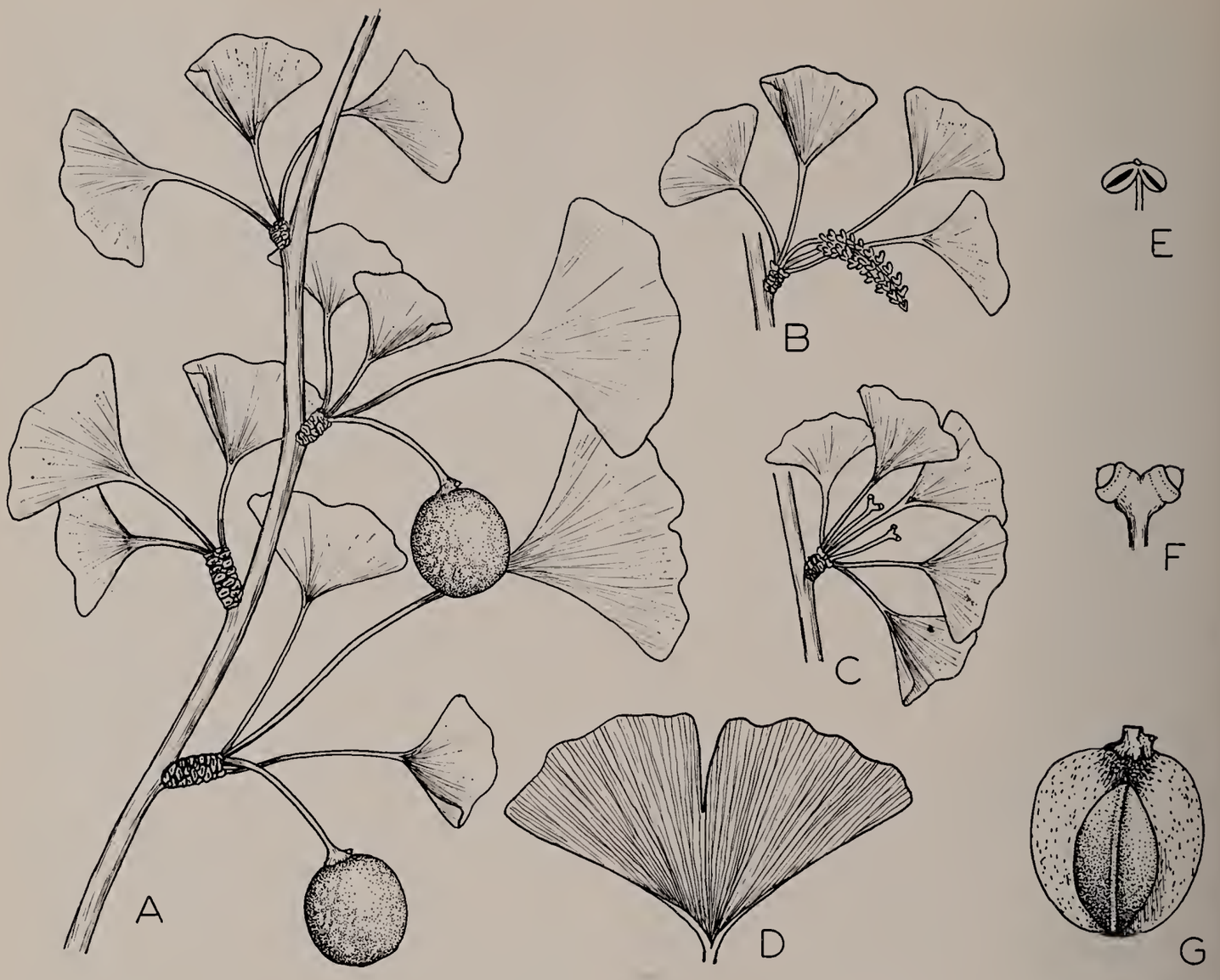



Fig. 2. *Ginkgo biloba.* A. A fruiting branch, X ½. B. Branch with male catkin, X ½. C. Branch with female flowers, X ½. D. A leaf showing venation, X 1. E. A stamen, X 4. F. A female flower, X 2. G. Section of seed showing nut, X 1.

shown that there is some difference between the chromosome apparatus of the male and female trees. If a simple technique can be devised to study this chromosome phenomenon, it will be of great help in eliminating young female trees in horticultural plantings.

The study of the only living survival of a very ancient and once dominant group of plants aids greatly our understanding of the past history of vegetation on the earth. Without this living material many paleobotanical problems will remain unelucidated. The fossil history of Ginkgo and its relatives, outside the scope of this review, is a subject much discussed in paleobotanical works. For a detailed and authoritative treatment, the work of Seward (1919) may be consulted.

## Geographical Origin

Since the middle of the last century when China was open to the exploration of the botanical collectors, most of these explorers were anxious to discover the native haunts of this famous plant, but though there were claims of finding this tree in the wild state, none seems to have received any recognition.

Among the earlier and also the widest claims was the one made by the noted traveller Mrs. Bishop toward the end of the last century. In various publications, as quoted by Masters (1902), by Henry (1906), referring to a letter of hers to the *Standard,* Aug. 17, 1899, and by Seward (1911), referring to her book *Untrodden Paths in Japan,* she reported that she had observed it grow-

ing wild in Japan in the great forests in the northern island Yezo, and also in the country at the sources of the Great Gold and Min Rivers in western China. Her claim, however, was seriously questioned by Henry, Seward and other authors. Wilson (Rehder & Wilson 1913, Wilson 1916) is of the opinion that the tree in the forests of Japan and western China that Mrs. Bishop took for the Ginkgo was Cercidiphyllum. Wilson states that he had never met with a spontaneous specimen and in his opinion the tree no longer exists in the wild state.

All botanists and foresters of Japan deny that Ginkgo is indigenous in any part of Japan, but was definitely introduced from China. Plant explorers sometimes observed the plant in parts of China in natural woods but these were often passed as escapes from cultivation or only in a semi-wild state. Often to deny the assertion that it still occurs wild in China, the statement to that effect made by Wilson, because of his extensive experience in China, is usually quoted.

However, Wilson's exploration in China, though extensive, covers only a small part of the country. He collected especially in the Lushan area in northern Kiangsi in eastern China and more widely in western China in western Hupeh and Szechuan. As most of the curious conifers in China and Japan, which are many, have a very limited range of distribution, it is unsafe to make a categorical statement about their range and occurrence. For instance, the recently discovered and much discussed Metasequoia occurs in a small area in western China within the region extensively searched by Wilson on his many trips but was only narrowly missed by his itinerary.

Henry pointedly notes in 1906 (Elwes & Henry 1906) that "Its native habitat has yet to be discovered; and I would suggest the provinces of Hunan, Chekiang, and Anhwei in China as likely to contain it in their as yet unexplored mountain forests." None of the many modern plant explorers working in China during the last hundred years was familiar with the historical records of Ginkgo to guide them in their explorations, and Henry's statement, attesting to his wide knowledge of the Chinese flora and his sagacious observations, is closest to the truth. As noted above, early Chinese records clearly indicate that southern Anhwei, especially the region of Ningkuo and Suancheng, is the area where Ginkgo originates. Both are now names of cities, but formerly Ningkuo was also the name of a larger district with modern Suancheng as its leading city. And in modern plant exploration, the most reliable reports of Ginkgo as a wild plant also came from this area, the mountain region along the border of Anhwei and Chekiang.

Frank Meyer, botanical explorer for the United State Department of Agriculture reports[1] that "the Ginkgo grows spontaneously near Changhua Hsien, about 70 miles west of Hangchou in the Chekiang province, China." There "the trees are so common that they are cut for firewood." Wilston (1916) says that "it is, however, by no means certain that this is the original home of the Ginkgo as these trees may all have descended from a planted tree." But he says further than "Meyer's discovery, however, is interesting, for there is no other evidence of the Ginkgo growing spontaneously or that it is cut for any purpose."

The area visited by Meyer lies in the western part of the Tien Mu Shan Range, along the northwestern border of Chekiang and southeastern Anhwei. It is in immediate continuation with the Ningkuo and Suancheng area where early Chinese records place the original home of Ginkgo. The highest mountain of this range reaches 5,075 feet.

Wilson's assertion that these ten square miles of Ginkgos may have all descended from a planted tree seems to be highly improbable. Moreover, this area was visited subsequently by other Chinese botanists, and they also noted the same extensive occurrence of the Ginkgo tree in a spontaneous state. In the twenties and thirties, Ginkgo was observed and collected in that area repeatedly by Cheng, Tsoong, and others (Cheng & Chien 1933), and Cheng notes especially that "This tree is very common in Tienmu-shan, growing in association with coniferous and broad-leaved trees. It seems to grow spontaneously in that region."

In this area and the surrounding regions, the Ginkgo also commonly occurs as a cultivated tree, more frequently so than in other parts of China. This is borne out by my own observations as I lived in southern Kiangsu for many years and also travelled extensively in northern Chekiang and southern Anhwei although not in the Tien Mu Shan area. As early as a hundred years ago, Fortune (1847, 1857) observed enormous specimens near Huchow and Ningpo in northern Chekiang and also in southern Kiangsu. In the nearby Chuki District, Tseng (1935) records a number of varieties of Ginkgo trees cultivated for their nuts.

Southeastern China, especially southern Anhwei and Chekiang, is the home of many rare plants. Among the conifers and taxads, this is the native haunt of the monotypic endemic Pseudolarix and Nothotaxus, and also *Torreya grandis, Carya cathayensis* and other rare species. It is the refuge of many relict plants. The case of the Ginkgo is very similar to *Torreya grandis* and *Carya cathayensis,* which occur also in this area both in wild and cultivated conditions, for their

[1] The quotations are from Wilson (1916), who does not cite the source. I have not been able to trace these to any of Meyer's publications.

edible nuts. Undoubtedly the last refuge of Ginkgo lies also in this area, a fact not only sustained by historic records but also corroborated by the observations of modern botanical explorers. (Figs. 3, 4).

Ginkgo is sometimes also observed in a supposedly wild or semi-wild state in other parts of China, especially in the mountains of the southwest, in Kweichow, Szechuan, etc. It may be that the natural range of Ginkgo is fairly wide and scattered, but undoubtedly the area in southern Anhwei and northern Chekiang in eastern China is the center of origin of all the cultivated trees, both in China and Japan as well as in other parts of the world.

## The Name Ginkgo

In recent times there have been considerable discussion and dispute on the name Ginkgo. Moule (1937, 1944), Thommen (1949) and others believe that as it is apparently intended by Kaempfer to give a romanized version for the Chinese ideographs Yin Hsing, it should be more correctly transliterated into the Japanese "Ginkyo." Some botanists, such as Pulle (1948) and Widder (1948), in following this view, consider Ginkgo as an "unintentional orthographic error" and replace it with Ginkyo. On the other hand Henry (Elwes & Henry 1906) and Barclay (1944) suggest that the name might be a transliteration of the Chinese ideographs Yin Kuo meaning Silver Fruit.

The prevalent Japanese name of the tree is Icho and the nut Ginnan. Moule, who examined Kaempfer's essential manuscripts in the British Museum




Fig 3. Map of China. Black dot = original habitat of Ginkgo; star = city of Kaifeng; dotted square = area covered by Fig. 4.




Fig. 4. Map of eastern China. Circle = approximate area of the original habitat of Ginkgo; elevations in feet

and found nothing like the word Ginkgo in these, is of the opinion that "according to Kaempfer himself, to the books, and to modern evidence, the name of the tree is icho and of the fruit ginnan; while the scarely known form ginkgo (ginkyo) seems to have got into *Am. Exot.*, and thence into scientific botany, by some slip or misprint which has not been explained."

The case, it seems to me, can be readily settled by a study of Kaempfer's original text, which some authors, such as Henry and Barclay, apparently failed to consult. Their suggestion that the original ideographs concerned being Yin Kuo (Silver Fruit) is untenable as Kaempfer clearly indicates his Ginkgo being a transliteration of Yin Hsing (Silver Apricot). Moreover, the name Yin Kuo does not exist either in the literature or as a colloquial name in China and Japan. It is not found in the twenty-five such names for the tree and nut as given by Moule (1937).

The name Ginkgo appears in the 5th and last fascicles of Kaempfer's work, published twenty years after he left Japan. This fascicle lists and describes the economic plants of Japan. He gives for most of the plants first their names in Chinese ideographs which, as he clearly states in the preface, are the literary names. These Chinese ideographs as pronounced in Japan are romanized and these are followed by romanized Japanese colloquial names. In a few cases the literary names are the same as colloquial names and these are indicated as such.

Thus in the case of Ginkgo, the Chinese ideographs Yin Hsing are given at the beginning of the item (p. 811) and again on the plate (p. 813). Ginkgo is not "the scarcely known form" of Moule, but the literary name as occurring in Japanese lit-

erature at the time and especially in all herbals then in use, which were either translations from the Chinese or Japanese works with plant names of Chinese origins.

Now that the derivation of the name Ginkgo was clarified there remained the problem of the form of transliteration. The first line of the item in Kaempfer reads thus: "Ginkgo, vel Gin an, vulgò Itsjò. Arbor nucifera folio Adiantino." This clearly shows that Kaempfer considers that there are two ways of pronouncing the same ideographs, either as Ginkgo or Ginan. It is also to be noted that in the description following he says that the fruit is called Ginnan. The above quoted line of Kaempfer including the Chinese ideographs is cited in Endlicher's Synopsis Coniferum (1847) in the synonymy of *Salisburia adiantifolia* Smith.[2]

As is well known the same Chinese ideographs may have several different pronunciations in Japanese, varying from Japanese sounds to several types of Chinese sounds borrowed from China at different ages and from different geographical areas. Kaempfer indicates two different ways of pronouncing Ginkgo. In the Japanese herbal Honzo Zufu of 1828 the name Ginkgo is also given in two sounds, with the note that Ginnan is a Chinese pronunciation of later origin. Koidzumi (1936) and Makino (1951) quote other Japanese authors that Icho is the Chinese pronunciation of Ya Chio in the Sung dynasty, and the former says also that Ginnan is a Chinese pronunciation of later times. I believe both these pronunciations Icho and Ginnan came to Japan from southern Kiangsu in China, near the region where the tree originated. In the modern Wu dialect of the area, Ya Chio is pronounced Ai Cho and Yin Hsing as Nin An, both closer to the Japanese names than to the Mandarian or northern Chinese.

The most disputed fact is the seemingly quaint spelling "Ginkgo" of Kaempfer. Moule (1944) quotes Arthur Waley that "Ginkgo is a distortion of Ginkyo, which is the logical and regular reading of the Chinese name (Yin Hsing), but has no existence in the real language," adding the remark that this "is the true account of the word."

These authors, however, are considering the modern pronunciation and romanization of the word while Kaempfer was writing about his observations made over 250 years ago. The pronunciation of these words at that time might be slightly different. Fortune (1863), for instance, observing this plant in Japan about a hundred years ago, says that the nut is called Ging Ko in Japanese shops.

In the work of Kaempfer, the individual Chinese character Hsing is romanized elsewhere as Kjoo or Koo. In the preface he says that some of the sounds, like k and g, especially in composite names, are not readily distinguished and he gives such examples as *K*oquan or *G*oquan and Kinari *g*aki or Kinari *k*aki. Thus in the case of Ginkgo, he might be rendering a sound which he thinks is closest to the one then prevalent.

Kaempfer's romanization of this word may be a vagary, according to modern pronunciation, but the difficulty of explaining this, as Barclay (1944) says, "to any one conversant with the vagaries of the many systems used for 'romanizing' the Japanese sounds, . . . . . will certainly not seem insuperable." The fact to be noted is that Kaempfer was romanizing sounds of over 250 years ago and at a time when even the many different systems of romanizing Japanese sounds were not in existence. Thus the modern rendering Kyo is to him Kjoo or Koo or Kgo, the first two as individual sounds, and the last in combination with other sounds. Also the name Icho was to him Itsjo. The word Ginkgo is apparently not a misprint as suggested by Moule, as it is correctly listed also in the Index of Kaempfer's work together with the other words discussed here. To reject his spelling because it does not conform with modern pronunciation seems most illogical. The name Ginkgo may be worth looking into etymologically, but as the original spelling of Kaempfer was correctly adopted by Linnaeus as a botanical name, nomenclaturally speaking, there is no ground to reject it as an "unintentional orthographic error." As Ginkgo it has been known for nearly 250 years and certainly will be known as such forever.

[2] Endlicher gives in his monograph of the conifers a number of Chinese names in ideographs, either cited from Kaempfer or added by himself. Besides Kaempfer, he is one of the few European botanists to use Chinese characters in their publications. It may be mentioned that botanist Endlicher was also an advertent and competent sinologist, although he did not seem to have studied the botanical aspects of the Chinese literature.

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# EARLY FLOWERING SHRUBS AT THE ARBORETUM

MARTHA H. STARR

Occupying a unique place among hardy woody plants is a small but well-loved group of trees and shrubs that, year after year, miraculously brighten the winter landscape with blossoms. Although they cannot compete in brilliance with the displays staged later by the Cherries, Crabapples or Lilacs, they are prized for their delicacy, fragrance and ability to bloom at a time of year when spring seems very "far behind."

Gathered together on a slope just inside the Hillcrest Avenue entrance gate at the Arboretum is a collection of these early shrubs and trees. The first to bloom are the Witch-hazels with their fragrant ribbon-like flowers. Sometimes as early as January the Vernal Witch-hazel, *Hamamelis vernalis,* develops a delicate tracery of reddish yellow blossoms against the winter background. This is followed in February or March by two other members of the family, *H. japonica* and *H. mollis.* The latter, the Chinese Witch-hazel, is a tall spreading shrub bearing comparatively large yellow flowers. It makes an excellent shrub for any garden. A hybrid, *H. japonica* x *mollis,* known as *H. intermedia* has shown much promise at the Arboretum. Although less showy than the yellow-flowered species, the large reddish flowers are extremely fragrant and hold up well when cut and brought indoors.

Also blooming with the Snowdrops and Crocuses are the Silver Maple (*Acer saccharinum*), the true Hazels (*Corylus* spp.), and the many Willows (*Salix* spp.) whose delicate green unfolding foliage is, to many, the very essence of spring. Two of the best of the "Pussy Willows", *Salix caprea* and *S. gracilistyla* are represented in the collection.

Soon after, while the Red Maples (*Acer rubrum*) are pushing out their cheery red flowers, the first of the Dogwoods come into their own. *Cornus officinalis* and *C. mas* are very similar, covered with tiny yellow flowers which lack the conspicuous white bracts of our native *C. florida.* Although lacking the fragrance of so many spring-blooming shrubs, these plants are both worth growing, not only for their early bloom but also for their good foliage, compact habit, and conspicuous red fruits borne in late summer. *C. officinalis* is to be particularly recommended because of its interesting exfoliating bark. Unfortunately, it is the more difficult of the two to obtain in nurseries.

A rare but choice plant blooming at this time is the Chinese *Chimonanthus praecox.* Closely related to the Magnolias, it bears small waxy flowers with yellow outer sepals and inner ones striped purplish-brown.

Winter heather (*Erica carnea*) and Winter Jasmine *(Jasminum nudiflorum)* are two plants which cannot be omitted. The latter is valued for cutting and forcing during the winter months.

The first of the Viburnums (*V. fragrans*) puts forth its pink buds at this time. Although inferior to other members of the genus in form and fruiting habit, it is well-loved for its early fragrant flowers. Another shrub recommended only because of its early flowering is *Forsythia ovata.* The other Forsythias which follow in ten days to two weeks are more floriferous.

*Lonicera fragrantissima,* as its name implies, is one of the most fragrant of the Honeysuckles. In an average winter we do not see it flower before the end of March; with two or three days of unseasonably warm weather, it will send out a few tentative white blossoms as early as January. Below is a record of its blooming dates over the last fourteen years which shows the wide variation possible. *L. Perpusii* and *L. Standishii* are two other early-blooming Honeysuckles. *L. Standishii* var. *lanciifolia,* with its leathery, lance-shaped leaves, is particularly commendable. These early Honeysuckles are the first of the shrubs to fruit—the red berries develop as early as June.

*Corylopsis* the Birches, Spice-Bush (*Lindera Benzoin*) and our native Trailing Arbutus (*Epigaea repens*) follow. With the Japanese Andromeda (*Pieris japonica*) come the first of the Rhododendrons, *R. dauricum* and the popular *R. mucronulatum* whose pale lavender flowers are so often seen growing in conjunction with *Forsythia.* The new *R. mucronulatum,* "Cornell Pink," a chance seedling discovered at Cornell University about 1932, is of special merit because of its pink blossoms at a time when the predominant colors are white, yellow or lavender. We hope to see this clone available in nurseries in the near future.

And here, with the Cherries and Star Magnolias about to burst into bloom, we leave the fragrant delicacy of the early flowers and plunge into another sudden, riotous Philadelphia spring.

A Comparison of Blooming Dates of *Cornus mas* and *Lonicera fragrantissima*:

| | *Cornus mas* | *Lonicera fragrantissima* |
|---|---|---|
| 1942 | April 1 | March 18 |
| 1943 | March 24 | March 24 |
| 1944 | April 9 | March 26 |
| 1945 | March 18 | March 17 |
| 1946 | March 11 | March 7 |
| 1947 | March 26 | March 28 |
| 1948 | No flrs. | March 22 |
| 1949 | March 11 | March 14 |
| 1950 | February 10 | January 17 |
| 1951 | March 7 | February 26 |
| 1952 | March 20 | January 26 |
| 1953 | February 20 | February 1 |
| 1954 | No flrs. | February 4 |
| 1955 | March 7 | March 9 |

# THE ARBORETUM LIBRARY

Janet L. Bowen

One of our Associates, upon the occasion of a recent visit to the Arboretum, expressed surprise on learning that she was permitted to borrow books from the Arboretum Library. We were, of course, delighted to acquaint her with the privileges which were hers in regard to the use of the Library, but the incident gave us pause. Perhaps other Associates as well as general readers of the Bulletin were unaware of their library privileges at the Arboretum; perhaps, indeed, some were unfamiliar with the extent and scope of the resources of the Library. Clarification of these points seemed in order and we therefore welcome this opportunity to bring the Library and its collections to the attention of our readers.

The Arboretum Library is one of nineteen departmental branches of the University of Pennsylvania Library. Comprising over 2,500 books and bound periodicals, the collection is housed in Thomas Soverign Gates Hall, the Arboretum Administration building at 9414 Meadowbrook Avenue. The library room is cheerful and attractive and serves on occasion as the center for Arboretum social functions. All the books are conveniently shelved and catalogued in accordance with the standard Dewey Decimal Classification system.

Realizing that a mere aggregation of books does not in itself constitute a living, working library, the Arboretum has adopted the policy of encouraging the use of its library facilities by all persons interested in the fields embraced in the collection. The Library is open from 9 a.m. to 4:30 p.m. Monday through Friday, and visitors are welcome to spend as much time as they wish during these hours. Books may be borrowed by all responsible individuals for a period of two weeks and may be kept longer "on call" for immediate return if needed by others.

Some idea of the scope of the collection may be obtained from the following list of categories into which the vast majority of the books fall:

- Agriculture
- Apiculture and Honey Plants
- Biology (general)
- Botany
  - Biography
  - Ecology
  - Floristics (regional and local floras)
  - General Botany (including textbooks, encyclopedias and publications of societies and botanical gardens)
  - Medical Botany (pharmaceutical works)
  - Morphology

Physiology
Phytopathology
Plant Distribution
Systematic Botany (Taxonomy)
Travel and Exploration
Forestry
Fruit Culture
Geology and Mineralogy
Horticulture (including general gardening; trees and shrubs for gardens; rock, wall and water gardens; ivies and ground covers; roses; azaleas and rhododendrons; house plants; flower arrangements; individual species)
Landscape Gardening
Paleontology
Planting Practices (including propagation, grafting, soil, planting methods, seed) and Plant Care (including fertilizers, pruning, blights, insect and weed control)
Zoology

The Library currently receives some sixty periodicals, many of them sent by arboretums and horticultural organizations throughout the country in exchange for the Morris Arboretum Bulletin. Twenty-three of these journals and bulletins are yearly bound and catalogued into the permanent collection. In addition, a goodly number of reprints, research notes, government publications and periodicals from foreign countries reach our shelves through exchange relationships.

A complete list of periodicals to be found in the Library would occupy too much space on these pages, but the following will suffice to indicate the nature of these acquisitions:

Agriculture Index
American Forests
American Journal of Botany
American Nurseryman
American Rhododendron Society Quarterly Bulletin
American Rose Magazine *(American Rose Society)*
Arboretum Bulletin of the University of Washington
Arborists News *(National Shade Tree Conference)*
Arnoldia *(Arnold Arboretum)*
Baileya *(Bailey Hortorium of Cornell University)*
Bibliography of Agriculture
Biological Abstracts (*Section D, Biological Sciences*)
Contributions of the Boyce Thompson Institute
Cornell Plantations
El Aliso *(Rancho Santa Ana Botanic Garden, Claremont, Calif.)*
Florist & Nurseryman
Flower Grower
Forestry Abstracts
Frontiers *(Academy of Natural Sciences)*
Garden Club of America Bulletin
Garden Journal *(New York Botanical Garden)*
The Garden Path *(Ohio Association of Garden Clubs)*
Gardening Illustrated (an English publication)
Gardeners Chronicle (an English publication)
Horticulture
Horticulture Abstracts
Lasca Leaves *(Southern California Horticultural Institute)*
Lloydia *(Lloyd Library and Museum, Cincinnati, Ohio)*
Missouri Botanical Garden Bulletin
Morton Arboretum Bulletin
National Horticulture Magazine *(American Horticultural Society)*
Park Maintenance
Pennsylvania Forests *(Pennsylvania Forestry Association)*
Plants and Gardens *(Brooklyn Botanic Garden)*
Reef Point Gardens Bulletin *(Max Farrand Memorial Fund, Bar Harbor, Maine)*
Rhodora *(New England Botanical Club)*
The Rose *(Philadelphia Rose Society)*
Royal Horticultural Society Journal
Shade Tree *(New Jersey Federation of Shade Tree Commissions)*
Trees
Washington Agricultural Experiment Station Bulletin
West Virginia Arboretum Newsletter
Wisconsin Arboretum News

# Evodia as a Bee Tree

Mr. Fred W. Schwoebel, Curator of the Langstroth Bee Garden of the Morris Arboretum, has recently published two interesting articles[1] calling attention to the highly desirable qualities of *Evodia Daniellii* as a bee tree.[2] This Oriental species, which is a member of the Rutaceae, or Rue Family, is perfectly hardy throughout most of eastern temperate North America and, according to Mr. Schwoebel, is avidly sought by bees in search of nectar for honey. The tree is easily grown from seed, develops rapidly, is essentially free from diseases and blooms in mid-summer. A future number of the Bulletin will carry a detailed account of this and allied species of the genus *Evodia*.

Since the appearance of Mr. Schwoebel's two articles we have received approximately 300 requests for seed. The purpose of this note is to extend to our readers the opportunity of securing seeds of this valuable plant. A self-addressed, stamped envelope will bring you a small quantity of seeds of this tree together with instructions concerning its cultivation.

[1] Gleanings in Bee Culture, Vol. 83, no. 11, 660, November 1955; American Bee Journal, Vol. 95, no. 12, 469, December 1955.

[2] See Cover. Photograph by Dr. E. J. Schreiner.

## ARBORETUM ACTIVITIES

*(Continued from page 2)*

### Advisory Council

The Board of Managers recently approved a suggestion of the Director that there be set up an Advisory Council of the Arboretum to meet with him occasionally to discuss the welfare and activities of the Arboretum. Mrs. E. Florens Rivinus graciously consented to accept the chairmanship of this group and the following persons have agreed to serve as members:

Mrs. Frederick L. Ballard, Jr.
Mrs. Albert C. Barnes
Mrs. C. Reed Cary
Mrs. Morris Cheston
Mr. Richard B. Chillas, Jr.
Mr. Lloyd M. Coates
Mr. Henry F. du Pont
Mr. Carl W. Fenninger
Mrs. Thomas S. Gates
Dr. David R. Goddard
Mrs. Albert M. Greenfield
Mrs. Gaylord P. Harnwell
Mrs. Flagler Harris
Mrs. Sidney Keith
Mr. John B. Kelly
Mrs. John F. McCloskey
Mrs. Frederic Rosengarten
Mr. Maurice Bower Saul
Dr. Russell J. Seibert
Mrs. E. Newbold Taylor
Mr. George D. Widener
Mrs. W. B. Whitney, 2nd
Dr. J. J. Willaman
Mrs. E. F. R. Wood

The newly formed Council held its first meeting in Gates Hall at the Arboretum on Thursday. January 12. This was essentially an organizational session at which the Director explained the educational and research objectives of the Arboretum and invited the members to make suggestions as to how the Arboretum might render wider and more effective service to the community. Future actions of the Council will be published from time to time in these pages. J.M.F., Jr.

# Morris Arboretum Bulletin

MAY, 1956

VOL. 7 NUMBER 2



*Ivies Along Oak Row*

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The Morris Arboretum Bulletin is published quarterly at Philadelphia, Pa., by the Associates of the Morris Arboretum, Chestnut Hill, Philadelphia 18. Subscription, $1.00 for four issues. Single copies, 30 cents. Free to Associates.

THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

CLASS OF MEMBERSHIP

| | | | |
|---|---|---|---|
| Contributing | $ 5.00 a year | Supporting | $ 25.00 a year |
| Sustaining | $10.00 a year | Sponsoring | $100.00 a year |
| | | Donor | $500.00 |

# Arboretum Activities

The winter of 1955-56 has been an unusually severe one at the Arboretum. The prolonged drought of last July and August and the heavy rainfall of early autumn were followed by cold weather, high winds and frequent snowfalls which began early in November and continued until mid-April. Although it is too soon to assess the damage which this combination of unfavorable conditions imposed upon our plantings, most of our major groups seem to have survived remarkably well. A future issue of the Bulletin will carry a detailed report on this situation.

## New Azalea Planting

Several beds have been laid out for a new azalea planting in the southeastern corner of the property along Hillcrest Avenue. Into these beds are being moved 175 azaleas which have been held under observation in our nurseries for a number of years. Most of these are Glenn Dale hybrids ranging in color from pure white through lavender to various shades of pinks and reds. The series also includes several hybrids of Chisholm, Merritt, Arnold, Bobbink and Atkins, Gable and

*(Continued on page 32)*

# The Cultivated Ivies

George H. M. Lawrence
*Bailey Hortorium, Cornell University, Ithaca, N.Y.*

Few plants are so well suited to such a wide range of horticultural use as the English ivy and its relatives. This quality is due to two principle factors. The first is the unusual situation of a hardy woody plant having a juvenile phase of growth, with its characteristic vine-like habit and usually lobed leaves, and followed under favorable conditions by an adult phase with a stiff shrub-like habit and entire heart-shaped leaves. The second is its capacity to produce bud sports or mutations while in the juvenile phase, — these being cut off and propogated as new foliage variants. The number that have been named and put on the market exceeds two hundred. Only two or three sports have been found and separated from the adult-phase. Other factors that have contributed to the popularity of this group are its ease of culture in the home as a foliage plant, its suitability in most temperate regions as a ground- and wall-cover outdoors, and the ease with which it may be propagated by cuttings.

The outdoor culture and display of the named kinds of ivy is made difficult because of the labor involved in training the plants and keeping separate the growth of adjoining clones. This difficulty has been resolved at the Morris Arboretum by growing each kind on separate trees of a very beautiful double row of oaks.[1] This collection, started there in 1945, is the best outdoor display of ivy clones known to me anywhere in this country or in Europe.

Ivies became very popular in Britain a century ago and by 1870 more than 70 named varieties were known. The plants of that era were grown primarily outdoors. Their popularity in America trailed that in Britain until the 1920's, when the introduction of the Ramosa strain of proliferating forms, first represented by 'Pittsburgh,' came on the market. By the mid-1930's the growing of ivies in the home and the naming of newly recognized sports reached fad-like proportions. Since then there has been some reduction of interest in them, as other foliage plants have competed successfully for attention, but with this there has been a levelling-off and a stabilizing in the number and kinds of named variants. The only comprehensive horticultural monograph of modern ivies is that by Lawrence and Schulze "The Cultivated Hederas" (Gentes Herbarum, 6: 106-173, 1942), now out-of-print and to be consulted only at the larger botanical libraries.

[1] See cover illustration by Dr. E. J. Schreiner.

Since 1942, more information has become available about these varieties, their hardiness, and their decorative limitations. Of significant importance also, has been the effect of the relatively new International Code of Nomenclature for Cultivated Plants on the naming of clones. The demands for information about the kinds of cultivated ivies have prompted the preparation and publication of this material. Much of the technical descriptive and nomenclatural data of the Lawrence and Schulze monograph have been omitted, including their extensive citation of synonyms and notes on introduction. Some of the illustrations of that work have been made available for inclusion here, and the keys reproduced here are based on those of the earlier work.

Prior to 1952, persons concerned with the nomenclature of cultivated plants followed the International Code of Botanical Nomenclature, a Code adequate for the botanist but less so for the horticulturist. With the adoption at the London Horticultural Congress in 1952 of an International Code for Cultivated Plants, a new guide was made available that is destined to produce greater uniformity in naming garden plants. This Code is based on all the principles of the botanical code and, in effect, carries on for the horticulturist where the other leaves off. There is complete harmony between the two.

It is useful to know how this Code affects the naming of ivies. In the first place, it differentiates between the wild plant the botanist designates as a variety and that which the gardener calls a variety. The differences between the two are largely genetical and have been reviewed in detail elsewhere (Baileya, vol. 3, pp. 177-181, Dec. 1955). In order to recognize the horticulturist's variety, the Code provides for its being called a cultivar (a condensation of 'cultivated variety,' a term proposed by L. H. Bailey in 1921). It is abbreviated as cv. Furthermore, the cultivar name, whether it be in Latin (e.g., *grandiflora*) or in a modern language (e.g., Pittsburgh) is to be treated as a vernacular name, enclosed in single quotation marks, and spelled with a capital initial (e.g., *Hedera Helix* cv. 'Walthamensis' and cv. 'Hahn's Self-branching').

Plants that must be propagated asexually (such as by grafting, budding, cuttings, and layering) are clones. Each clone is identical to the plant from which it was cut, unless mutation has occurred within a bud. The clone is a subdivision of a cultivar. If seed is sown from some cultivars, espe-

cially those of hybrid origin, the progeny may be very variable. Selections of desirable seedlings may be named individually and a stock of them be built up by asexual propagation. Thus one cultivar may give rise to many clones. The fancy-named ivies actually are clones. The Code provides that when a plant is always handled as a clone, the designator cl. may be used in place of cv. This device tells anyone that the plant must be propagated asexually if trueness to name is to be assured.

The Botanical Code requires that the first publication of all new varieties given Latin names must have the new name accompanied by a Latin description. This becomes absurd for new names of horticultural plants, and the Horticultural Code requires only that the name be in any modern language using the Roman alphabet and be accompanied by a description in such a language. The segregation of cultivars from varieties makes this simplification possible. A cultivar (or clonal) name may be published in any widely distributed printed periodical, catalogue or book, or in the registration lists of societies acting as official registrars for particular groups. The Code does require, however, that the name be accompanied by a description of the plant concerned. Publication of an illustration, without description, does not meet these requirements.

The nomenclature for species of Hedera, and for botanical varieties (e.g., *H. Helix* var. *baltica*) must continue to be in accordance with the Botanical Code. There have been no changes in recent editions of this Code that affect established names of Hedera species.

Five species of Hedera are in cultivation. Most of them are known to horticulturists only by their juvenile foliage and one of the best vegetative characters for the separation of the species is the type of hairs they bear. These hairs are small. Often they are like fringed scales that lie appressed to the epidermis. A good hand-lens is needed to distinguish the kinds and one should look first at twig-tips and leaf-petioles or under side of the leaf-blades when seeking these hairs. If the hairs are so dense as to present a mat-like surface, one should follow the stem back towards the older parts, where the abundance of hairs is much less. Illustrations of these hair types are provided. The key provided to the species is based on the vine-like often climbing juvenile growth phase. The clones are keyed out separately under their respective species.

In keying out these ivies, a minimum of terminology is required and most of it refers to the leaves. Those of the juvenile stage are variously lobed. The central lobe towards the tip is the *terminal lobe*. The two lobes formed by the more or less heart-shaped base are the *basal lobes;* these are sometimes small and likely to be overlooked. In a five-or-more lobed leaf the lobes between the terminal and basal lobe are called *lateral lobes*. The space or opening between two adjacent lobes is a *sinus*. In Hedera these sinuses may be rounded or angular. A rounded sinus is one whose base is obtuse and, conversely, an angular sinus is one whose base is sharp-pointed or essentially so. By geometrical definition, an angle greater than a




Fig. 5. *Hedera nepalensis*. A, juvenile foliage x ½; B, scale-like hair x 40.

right angle is obtuse, one less than a right angle is acute. Thus one may have an ivy leaf with rounded sinuses and the lateral veins forming acute angles with the midrib. Figures indicating leaf size are of the leaf-blade exclusive of its petiole. They are of the entire blade, including its basal lobes and not of the midrib only.

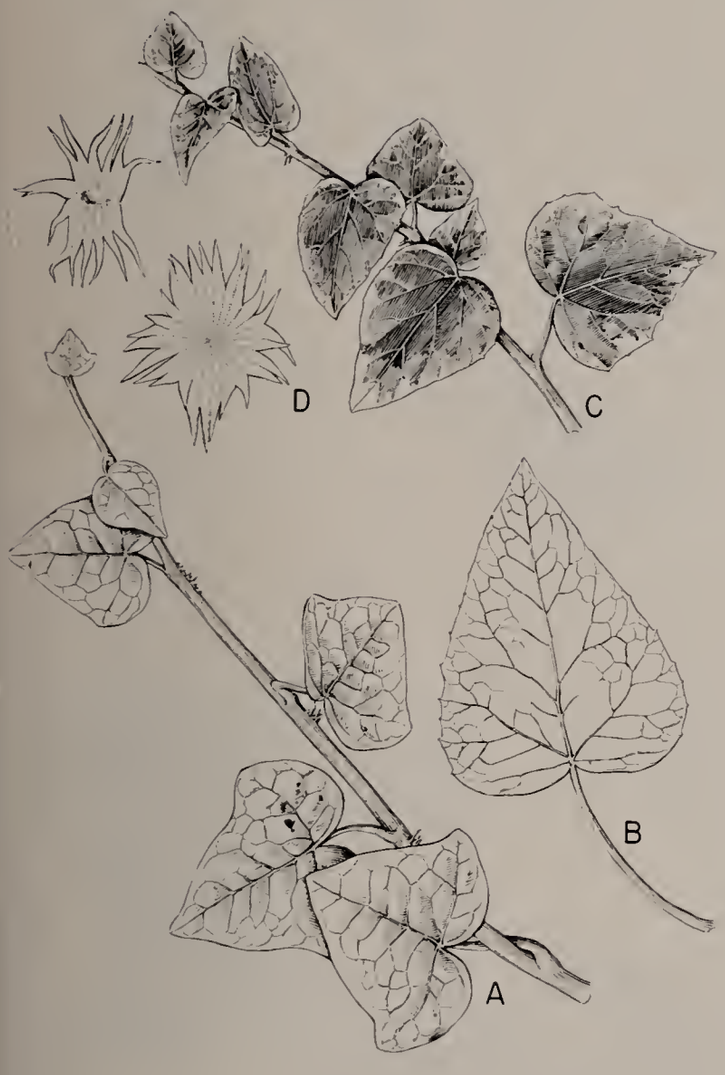



Fig. 6. *Hedera colchica.* A, var. *colchica,* juvenile foliage × ⅓; B, var. *dentata,* leaf, × ⅓; C, cl. 'Dentato-variegata' × ⅓; D, scale-like hairs × 25.

Caution: when keying out any ivies, especially the clones, it is essential to have at hand a twig bearing 8-12 leaves. *It is not usually possible to identify an ivy clone on the basis of a single leaf.* The variation between leaves may be considerable in some clones, and one must then be guided by characters as shown by the majority of the leaves of a twig.

KEY TO THE SPECIES OF HEDERA

1. Hairs uniformly stellate (borne on short stalks), rays 4-10 (rarely to 14). . . . . 5. *H. Helix*
1. Hairs mostly scale-like, flat against the surface and not stalked, rays 8-30. (Fig. 7-E.)
   2. Leaf-blade thin (not leathery), usually glossy on upper surface; the hairs of two kinds intermixed, some scale-like and flattened and a few stellate and stalked; twigs and petioles usually burgundy-red (green in two clones each with leaves variegated). 3. *H. canariensis*
   2. Leaf-blade leathery, often dull on upper surface; the hairs all scale-like; twigs and petioles green.
      3. Blades of leaves ovate with broadly wedge-shaped, heart-shaped bases, having strong celery-like odor when crushed; hairs mostly with 20-25 rays (Fig. 6-D) . . 2. *H. colchica*
      3. Blades of leaves usually elliptic-lanceolate with cuneate base, not at all or only slightly odoriferous when crushed; hairs having mostly 15-20 rays. (Figs. 5-B, 8-B.)
         4. Leaves much longer than wide, (usually 1-4 in. long), entire or only slightly lobed; fruit orange . . . . . 1. *H. nepalensis*
         4. Leaves not much longer than wide, (usually ⅝-1½ in. long), 3-5-lobed in juvenile stage; fruit black. . . . 4. *H. rhombea*

1. *Hedera nepalensis* K. Koch. [Syn. *Hedera himalaica* (Hibb.) Tobler, *H. cinerea* (Hibb.) Bean]. (Fig. 5.) NEPAL IVY.

This is an Asiatic species to be found native from Afghanistan to Kashmir, Nepal, and Assam. It is readily distinguished in the juvenile stage by its elliptic-lanceolate leaves of a dull green color mottled with small interstitial zones of gray-green between the lateral veins, and by the 2-4 narrow lobes on each side. The marigold-yellow fruits are distinctive when available. The Poets ivy (rare in U.S.A.), a botanical variety of *H. Helix,* also produces yellow fruits, but is readily distinguished by its foliage and hair type.

2. *Hedera colchica* K. Koch [Syn. *Hedera cordifolia* Hibb., *H. coriacea* Hibb., *H. Helix Raegneriana* Nicholson]. (Fig. 6.) COLCHIS IVY.

A species native throughout much of the forest area of southeastern Europe and Asia Minor to northern Iran and Turkey. It is easily identified by its thick leathery leaves of dull dark green color which emit a celery-like odor when crushed. It is reasonably hardy and can be grown in Rehder's hardiness Zone 5. Two variants are known in addition to the typical.

1. Leaves with entire margins. . . . . var. *colchica*
1. Leaves with weakly and often sparsely toothed margins.
   2. Foliage uniformly green in color
      . . . . . var. *dentata*

2. Foliage variegated ivory, to cream-color, at least marginally . . . . . cl. 'Dentato-variegata'

Var. *dentata,* sometimes known as BULLOCKS-HEART IVY, is native in the Province of Batum, or the Black Sea, adjoining Turkey. Material passing in the trade as *H. colchica minor* is *H. Helix* cl. 'Scutifolia Minor.'

3. *Hedera canariensis* Willd. [Syn. *H. algeriensis* Hibb., *H. maderensis* K. Koch, *H. azorica,* Carr.] (Fig. 7.) ALGERIAN IVY.

A native of the Azores, Canary and Madeira Islands, and North Africa, this species and its variants are more commonly cultivated than any other except the English ivy, *H. Helix*. It is hardy in Rehder's Zone 6, and in favored locations of Zone 5. Most of the large-leaved variegated ivies of the dime-store and florists' shop trade are of this species, and it is grown abundantly outdoors along the West Coast.

The species is the only one producing bright burgundy-red twigs and leaf-petioles. Its thin leaves are large, glossy, and more apple-green in color than are those of other species. It is closely related to *Hedera Helix* and in its adult stage is not so easily distinguished as are other species.

KEY TO THE HORTICULTURAL CLONES

1. Plants with uniformly green leaves; twigs and petioles burgundy-red . . . . . var. *canariensis*
1. Plants with variously variegated leaves.
   2. Twigs and petioles green.
      3. Leaves pale green with darker network of veins and often with cream-colored variegated areas; blades often digitate in outline. . . . . cl. 'Viridis'
      3. Leaves uniformly variegated with ivory to cream-colored margins, occasionally some leaves all white. . . . . cl. 'Canary Cream'
   2. Petioles and usually the twigs burgundy-red; leaves various.
      4. Leaves dark green marginally; mid-section of blade streaked with light green or ivory. . . . . cl. 'Striata'
      4. Leaves cream-colored or ivory variegated along margin, usually broadly so; mid-section greenish.
         5. Margins cream- or ivory-color; mid-section usually a blue- or gray-green [Syn. 'Gloire-de-marengo']. . . . . cl. 'Variegata'
         5. Margins flecked or spattered with green; mid-section usually yellowish-green. . . . . cl. 'Margino-maculata'

4. *Hedera rhombea* (Miq.) Bean [Syn. *Hedera Helix* var. *rhombea* Miq., *H. japonica* Paul not Jungh., *H. Tobleri* Nakai]. (Fig. 8.) JAPANESE IVY.




Fig. 7. *Hedera canariensis*. A, var. *canariensis* × ⅓; B, cl. 'Variegata' × ⅓; C, cl. 'Striata' × ⅓; D, cl. 'Margino-maculata' × ⅓; E, scale-like hair × 25.




Fig. 8. *Hedera rhombea.* A, juvenile foliage × 1; B, hair × 40.

This ivy is strictly a Japanese native, occurring on most of the islands except the northern island of Hokkaido.

It is separated from the Nepal ivy by the very broadly ovate juvenile leaves which are 3-5-lobed, and from the Colchis ivy by the lobing of the leaves and the absence of a pungent odor when the leaves are crushed. From the English ivy it is best distinguished by the flattened scale-like hairs (stellate and stalked in *H. Helix*).

A variegated clone, 'Variegata,' differs from the type only in the narrow marginal variegation of the leaves. It is not common.

5. *Hedera Helix* Linn. ENGLISH IVY.

This is the most widely distributed species of the genus and is widespread over most of western Europe. The typical form (var. *Helix*) and the var. *hibernica* are naturalized in wooded areas of Virginia and North Carolina. It is hardy in most parts of the United States, and its var. *baltica* is probably the most hardy of all the variants.

Typical *Hedera Helix* is distinguished from its varieties and clones by its juvenile foliage which is dark green in color with prominently whitish veins as seen from above, the leaves 1¼ in. long or longer, 5-lobed, and the bases deeply cordate. The variant separated from it with the greatest difficulty is var. *baltica,* and the only reliable basis known to me is that in the typical form the stellate hairs are predominantly 4-6-rayed, while in var. *baltica* they are predominantly 8-rayed.

The key to varieties and clones given below is based on juvenile foliage. Except for var. *poetica,* none can be identified on the basis of adult foliage and reproductive structures.

## THE VARIETIES AND CLONES OF *HEDERA HELIX,* THE ENGLISH IVY.

Variants of English ivy deserving of individual names probably number about sixty, and by some enthusiasts they are considered to number many more. In general, they fall into one of three clear-cut groups, distinguished as follows:[2]

1. Plant producing lateral branchlets prolifically, at least along the ends of the stems, in leaf axils. . . . . Group I

1. Plants with lateral branchlets few, and never prolific in their production.
   2. Leaves uniformly green in summer (sometimes tinged reddish purple in winter if growing outdoors) . . . . . Group II

[2] A key, which is a device to assist one in identification of unknown plants is composed of a series of paired propositions. The statement of one proposition is, in general, the opposite of the other. The two propositions of a pair are identified by the same number. When using a key, have the specimen in hand and always read both propositions of a pair before deciding which is more closely matched by the specimen.

2. Leaves variegated with white, or shades of yellow or yellowish-green, or uniformly whitish or yellowish throughout . . . . . Group III

Group I was appropriately designated the Ramosa ivies by Alfred Bates. They are also known as the "self-branching" ivies. The original member of the group is 'Pittsburgh,' believed to be a derivative of *H. Helix* var. *hibernica* and was introduced sometime prior to 1920. These clones are budsports and highly unstable. The distinctions between them not only are slight but are inconstant. It is possible to propagate non-typical branches of a typical plant and produce one wholly unlike its "parent." Some of these clones have been patented. More alleged kinds are in the trade than are recognized here, and the omission of some from the key below reflects an inability to find bases for distinguishing them.

### Key to the clones of the Ramosa Group (Group I) (Fig. 9)

1. Leaves variously variegated white or ivory-yellow or marbled with varying shades of green.
   2. Variegation of the leaves, mostly cream-colored or whitish, confined to the marginal areas.
      3. Variegation of a flecked pattern, the foliage primarily green and appearing spattered ivory cream and gray . . . . . 1. cl. 'Ruth'
      3. Variegation of blotches, marbling or of major zonations.
         4. Leaves mostly ½-1 inch long (an occasional leaf may be longer); green in mid-section, always 3-lobed. . . . . 2. cl. 'Silver King'
         4. Leaves mostly 1-2½ inches long; gray-green, often marbled with green, in mid-section, sometimes 5-lobed.
            5. Edges of leaves usually reddish-purple. . . . . 3. cl. 'Pittsburgh Variegated'
            5. Edge of leaves "white."
               6. The "white" portion of leaves of much greater area than the "green." . . . . . 4. cl. 'Lee's Silver'
               6. The "white" portion of leaves narrow, and of less area than the "green." . . . . 5. cl. 'Silver Emblem'
   2. Variegation of the leaves formed by a marbling of the surface in shades of yellow-green, and at least a yellow-green area bordering the midrib, the margins green.
      7. Petioles ¼-¾ inch long, internodes of axillary shoots ¼ inch long or less. . . . . 6. cl. 'Merion Beauty'
      7. Petioles mostly 1 inch long or more, internodes of axillary shoots mostly ⅝-1 inch long . . . . . 7. cl. 'Green Quartz'

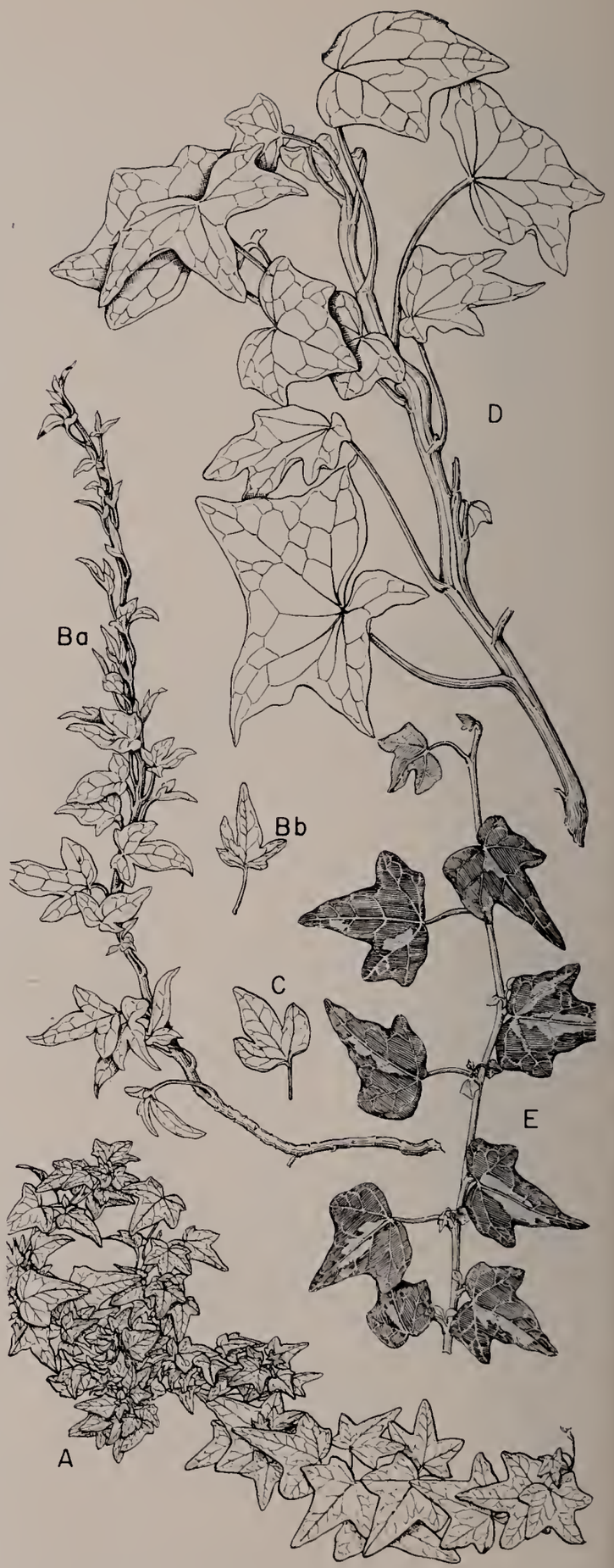



Fig. 9. *Hedera Helix* clones. A, 'Pittsburgh'. B, 'Meagheri': Ba, branch; Bb, leaf. C, leaf of 'Pin Oak'. D, 'Albany'. E, 'Green Quartz'. All × ½.

1. Leaves uniformly green, or only the veins of lighter color.
   8. Twigs strongly fasciated (broadly flattened); leaves to 3½ inches long (Fig. 9-D) . . . . . 8. cl. 'Albany'
   8. Twigs round to somewhat flattened (but not fasciated); leaves 2 inches long or less.
      9. Terminal lobe of leaf broadest above the base.
         10. Leaves flat, not acutely concave above, mostly 3-lobed or entire. . . . . 9. cl. 'Pin Oak'
         10. Leaves often trough-shaped, mostly 5-lobed. . . . . 10. cl. 'Meagheri'
      9. Terminal lobe broadest at its base.
         11. Leaves 1-3-lobed or entire.
            12. Lower side of lateral lobes convex. . . . . 11. cl. 'Sylvanian'
            12. Lower side of lateral lobes concave. . . . . 12. cl. 'Maple Queen'
         11. Leaves mostly 5-lobed.
            13. Basal lobes never well developed. . . . . 13. cl. 'Maple Queen'
            13. Basal lobe, when leaf is 5-lobed, often angular and prominent.
               14. Leaves flat or essentially so.
                  15. Leaf-blades 1-1¾ inches long. . . . . 14. cl. 'Pittsburgh'
                  15. Leaf-blades 2-2¾ inches long. 15. cl. 'Hahn's Self-branching'
               14. Leaves very strongly crisp-undulate or contorted. . . . . 16. cl. 'Holly'

The variegated Ramosa ivies fall into two types, those of "white" variegation (nos. 1-4) and those of "green" variegation. It is probable that "Pittsburgh Variegated' introduced by W. A. Manda, is the oldest, with 'Lee's Silver' next. A study of the plants would indicate that 'Silver King' and 'Silver Emblem' are derivatives of 'Lee's Silver' and that the distinction of each is to be maintained only by careful selection of propagating stocks. No differences have been noted between the so-called 'Jubilee' and 'Silver King,' although some plants of the former seem to be slightly more prolific in branching. All are slow growers, and probably 'Lee's Silver' is the slowest.

The variegation of 'Merion Beauty' and 'Green Quartz' is more conspicuous on foliage exposed to full sun than on that in partial shade. Well-grown plants often show three shades of marbling. The first is a sport of 'Pittsburgh,' and was introduced about 1937, the second is one of 'Pittsburgh Variegated,' and introduced a few years earlier. In 'Merion Beauty' the leaves of the older stems are green, marbled with lighter shades along the midrib and lateral veins. This pattern occurs also in 'Green Quartz' where the variegation is more yellowish and the veins are even brighter yellow in the marbled zones.

All of the non-variegated clones of this complex are believed to be derivatives of 'Pittsburgh,' a clone introduced by Paul S. Randolph, of Verona, Pa., who had stocks of it on the market in 1920.

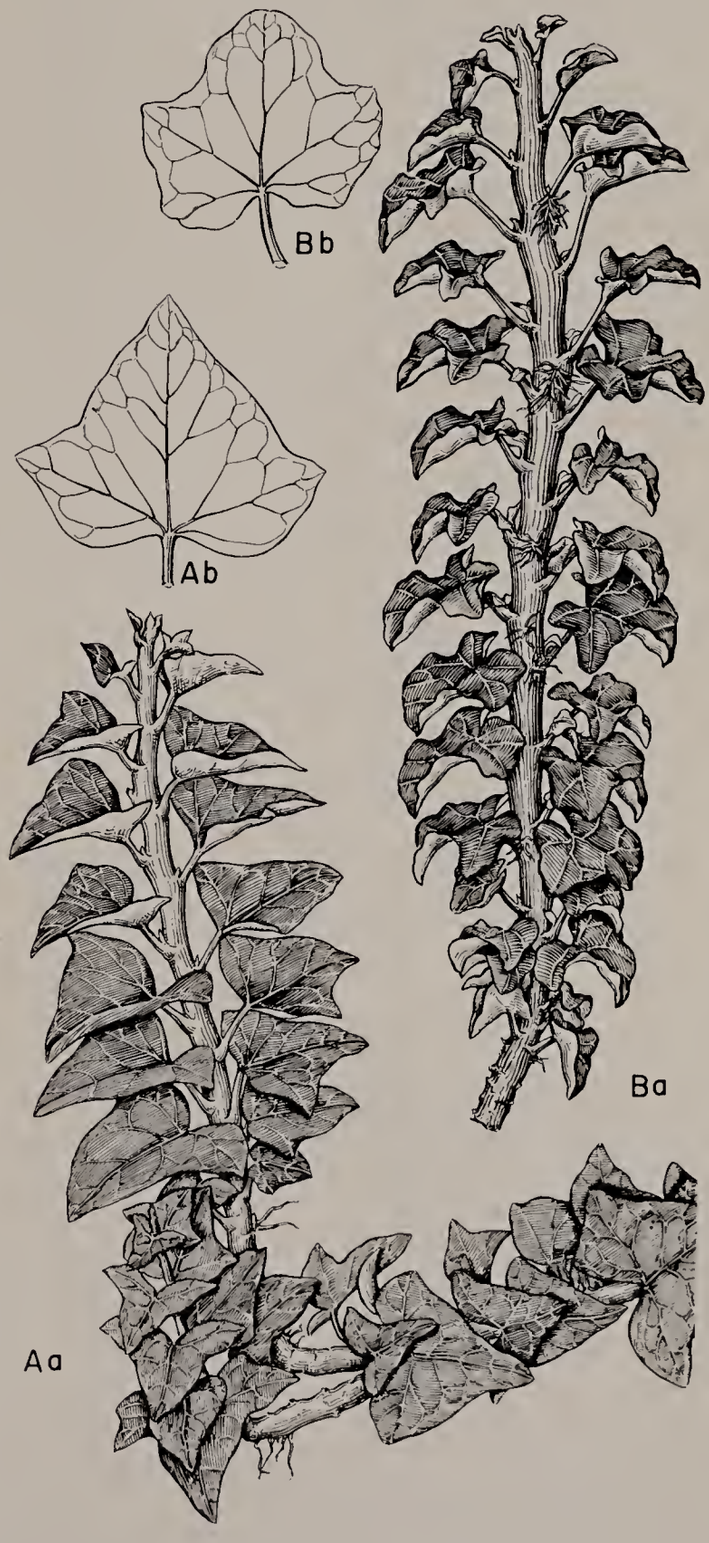



Fig. 10. *Hedera Helix* clones. A, 'Erecta': Aa, branch × ¾; Ab, leaf (flattened) × 1. B, 'Conglomerata': Ba, branch × ¾; Bb, leaf (flattened) × 1.

'Albany' was first propagated in 1931 and introduced in 1935 by Fred A. Danker, an Albany, N. Y. florist. 'Meagheri' (known also as 'Green Feather') was introduced by him about 1939. The clone 'Pin Oak' introduced by Henry Faust, Inc. of Merion, Pa., in 1941, differs from 'Meagheri' in the leaves flat and not trough-shaped, predominantly 3-lobed. In 1942 the same firm introduced another selection called 'Pin Oak Improved.' 'Hahn's Self-branching' was introduced by Sylvan Hahn in 1932 as a sport of 'Pittsburgh' and most of the material currently listed as the former is identifiable with the more prolific and smaller leaved 'Pittsburgh.' 'Sylvanian' (Plant Patent no. 430) was introduced by Sylvan Hahn in 1940, and is sometimes improperly designated 'Sylvan Beauty.'

Group II contains among others, all the older green-leaved clones of English ivy. It has the largest number of named kinds. In attempting to identify its members, be sure to refer to Group III any whose leaves are variegated yellowish-green to ivory-white, even if only a minority of the leaves are so marked.

The clones of this group are distinguished as follows:

1. Habit of plant stiffly erect, the stems usually few, not flexuous. (Fig. 10)
   2. Tips of leaves mostly acute . . 17. cl. 'Erecta'
   2. Tips of leaves mostly rounded. . . . . 18. cl. 'Conglomerata'

1. Habit of plant trailing or climbing, the stems usually abundant and flexuous.
   3. Leaves without lateral lobes, the basal lobes conspicuous or not so. (Fig. 11)
      4. Base of leaf deeply cordate, basal lobes often overlapping, upper surface of leaf dull.
         5. Terminal lobes rounded in most leaves of a twig . . . . . 19. cl. 'Deltoidea'
         5. Terminal lobes acute in most leaves of a twig. . . . . 20. cl. 'Scutifolia'
      4. Base of leaf truncate to cordate, basal lobes not overlapping, sometimes the basal lobes scarcely apparent, leaf apex acute or acuminate.
         6. Leaves glossy above when young, apices acuminate. . . . . 21. cl. 'Glymii'
         6. Leaves dull above when young, apices with convex margins.
            7. The leaves 1-2½ inches long. . . . . 22. cl. 'Scutifolia'
            7. The leaves ½-1 inch long. . . . . 23. cl. 'Scutifolia Minor'
   3. Leaves mostly lobed laterally.
      8. Terminal lobe about the same size as, or only slightly larger than, the lateral lobes, the leaf usually 5-7-lobed (if 3-lobed, see below in Second no. 8). (Fig. 12)




Fig. 11. *Hedera Helix* clones. A, 'Glymii'; B, 'Deltoidea'; C, 'Scutifolia'; D, 'Scutifolia Minor'. All × ½.




Fig. 12. *Hedera Helix* clones. A, 'Digitata'; B, 'Crenata'; C, 'Old Garden'. All × ½.

9. Leaf wavy or coarsely undulate; lobes often with 1-2 obtuse teeth along margin. . . . . 24. cl. 'Crenata'
9. Leaf flat or somewhat concave from above, the margins not coarsely undulate (wavy); lobes usually without marginal teeth.
10. Lobes usually 5 in number, the terminal one slightly longer and broader than the laterals, the sinuses about as wide as the lobes. . . . . 25. cl. 'Palmata'
10. Lobes 5-7, of nearly equal length, the sinuses usually narrower than the lobes.
11. Leaves broader than long, the lobes short and abruptly acute. . . . . 26. cl. 'Old Garden'
11. Leaves as long as wide or longer, the lobes triangular-lanceolate or narrower. . . . . 27. cl. 'Digitata'

8. Terminal lobe markedly larger than the lateral lobes (often twice as long as wide or longer), the blade 3-5-lobed.

12. The leaf-blade strongly undulate, ruffled, or crispy-wavy.
13. Leaves deeply lobed
28. cl. 'Fleur'
29. cl. 'Curly Locks'
30. cl. 'Manda's Crested'
31. cl. 'Telecurl'
32. cl. 'Williamsiana'
13. Leaves scarcely or only shallowly lobed.
33. cl. 'Parsley Crested'
34. cl. 'Monstrosa'
35. cl. 'Pixie'
36. cl. 'Ripples'

12. The leaf-blade flat or only the margins undulate.
14. The terminal lobe usually 2-4 times as long as wide, narrowly lanceolate. (Fig. 13)
15. Leaves 3-5-lobed, terminal lobe broadest at base, without marginal teeth, dark bronzy green. . . . 37. cl. 'Minima'
15. Leaves 5-lobed, terminal lobe usually broadest about ⅓ of its length above base, frequently with 1-2 marginal teeth, bright green. . . . 38. cl. 'Pedata'

14. The terminal lobes rarely more than twice as long as wide, broadly lanceolate to triangular in form.
16. Base of leaf deeply cordate with sides of lateral lobes usually overlapping, at least on most leaves. (Fig. 14)
17. Midvein of uppermost lateral lobe forming a right or obtuse angle with leaf midrib; veins greenish-white. . . . . 39. cl. 'Sagittæfolia'

17. Midvein of uppermost lateral lobe usually forming an acute angle with midrib; veins whitish and with narrow whitish zone paralleling them. . . . . 40. cl. 'Helvetica'

16. Base of leaf rounded to cordate, lateral lobes not overlapping. (Fig. 15)
    18. Veins conspicuously whitish (actually greenish-white) on upper surface.
        19. Leaves mostly less than 1 inch long. . . . . 41. cl. 'Walthamensis'
        19. Leaves more than 1⅓ inches long.
            20. Most leaves predominantly and conspicuously 5-lobed, the bases usually deeply cordate.
                21. Hairs mostly with 8 rays. . . . . 42. var. *baltica*
    21. Hairs mostly with 4-6 rays. . . . . 43. var. *Helix*[3]
    20. Most leaves predominantly 3-lobed (some may be weakly 5-lobed), their bases often truncate or shallowly cordate.
        22. Sinuses shallow and obtuse (or nearly absent) between terminal lobe usually convex. . . . . 44. cl. 'Scutifolia'
        22. Sinuses deep, usually acute, sides of terminal lobe usually straight or concave, often finely undulate. . . . . 45. cl. 'Triloba'

18. Veins green on upper surface.
    23. Leaves large, predominantly 3-5½ inches across.
        24. Blades light green, often tinged reddish; terminal lobe much longer than broad. . . . . 46. cl. 'Long Point'[4]
        24. Blades dark green; terminal lobe as broad as long (or nearly so), the sides usually curved convexly.
            25. Sinuses very shallow and wide. . . . . 47. var. *hibernica*
            25. Sinuses deep, narrowly acute. . . . . 48. cl. 'Lobato-major'
    23. Leaves small, predominantly 1½-3 inches wide.
        26. Young leaves uniformly light greenish-yellow, older ones green. . . . . 49. cl. 'Russell Gold'
        26. Young leaves green.
            27. Twigs brownish-purple; leaves thin, with purplish cast. . . . 50. cl. 'Gracilis'
            27. Twigs green (except on sunny side); leaves thick, not purplish.

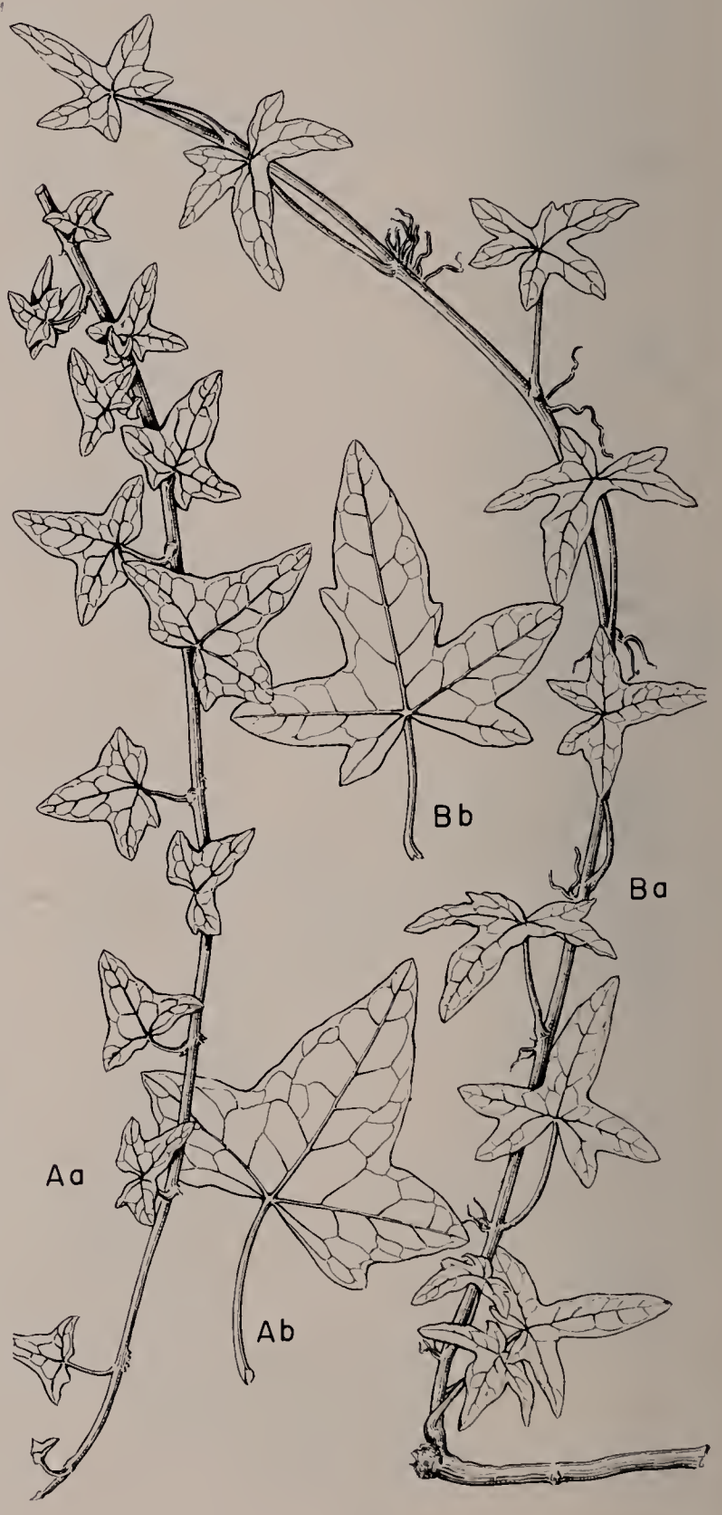



Fig. 13. *Hedera Helix* clones. A, 'Minima': Aa, branch × ½; Ab, leaf × 1. B, 'Pedata': Ba, branch × ½; Bb, leaf × 1.

[3] By recent international agreement, the epithets *typica*, *genuina*, etc., once used to designate the typical form of a species, have been discarded. It is now directed that the typical form be indicated by repeating the species epithet. Typical English ivy has the scientific name, *Hedera Helix* var. *Helix*.

[4] The clone 'Long Point' originated at the W. A. Manda nurseries and was named by Alfred Bates, who placed it in the Ramosa Group (1). It is a derivative of 'Pittsburgh', but more often than not, it fails to show the precocious proliferating growth character of the Ramosa Group. Some plants of 'Pittsburgh' and of 'Hahn's Self-branching' fail to show the proliferating habit, especially when grown outdoors, and may key out to 'Long Point' in this treatment.

28. Terminal lobes of most leaves slightly longer than wide, the basal and lateral lobes often united without an intervening sinus. . . . . 51. cl. 'Scutifolia'

28. Terminal lobes of most leaves not longer than wide, the basal and lateral lobes usually separate and distinct. . . . . 52. cl. 'Emerald Gem'

Less is known about the origins of these varieties and clones than of those in Group I because, for the most part, these have been known for a century or longer. Most of them are of British origin and are described and figured in the writings of Shirley Hibberd and William Paul.

Two of the group are botanical varieties and, although generally propagated as clones, occur in the wild. The var. *baltica,* known as Baltic ivy, forms a ground cover in pine woods along the Baltic Sea. The var. *hibernica,* known as Irish ivy, is of less doubtful origin as a native of Ireland, but has been established in the woods of County Kerry since before 1836. It is one of the most commonly cultivated sorts in eastern United States, as concerns those used outdoors for ground covers and screens. It is readily distinguished by its large glossy 5-lobed leaves with green venation. It is a rapid and vigorous grower.

The erect shrubby clones known as 'Conglomerata' and 'Erecta' are very distinct. The largest seen by me was in California, where it stood 4 feet tall and wide. 'Conglomerata' appears to be of German origin (1870) and soon thereafter was introduced into England, where in 1871 it was referred to as "a new ivy named *Hedera conglomerata.*" The clone 'Erecta' was recognized as distinct by Schulze in 1942 and passes in the trade as 'Conglomerata Erecta.' Both are very slow growers, probably the slowest of all ivies.

The clones with ruffled blades pose a nomenclatural problem. All seem to be of recent origin, and some have been derived from the usually precocious 'Holly.' That treated above as 'Monstrosa' by which name it has been known in Europe for perhaps 25 years is known also as 'Parsley Crested' and 'Parsley Curl.' The names 'Fleur,' 'Telecurl' and 'Manda's Crested' have been applied to clones of this group having a large terminal lobe and rather deep sinuses. In 'Manda's Crested' the leaves are coarsely wavy and not at all crisp-curly. 'Webers Californian' is even less strongly wavy. 'Williamsiana' has crisped-margined leaves, dark glossy green above with paler venation and a conspicuous narrow central lobe. Its origin is not not known to me.

The plant known as 'Russell Gold' is of English origin, introduced about 1934. In this clone the youngest leaves are distinctly yellowish-green (sap-

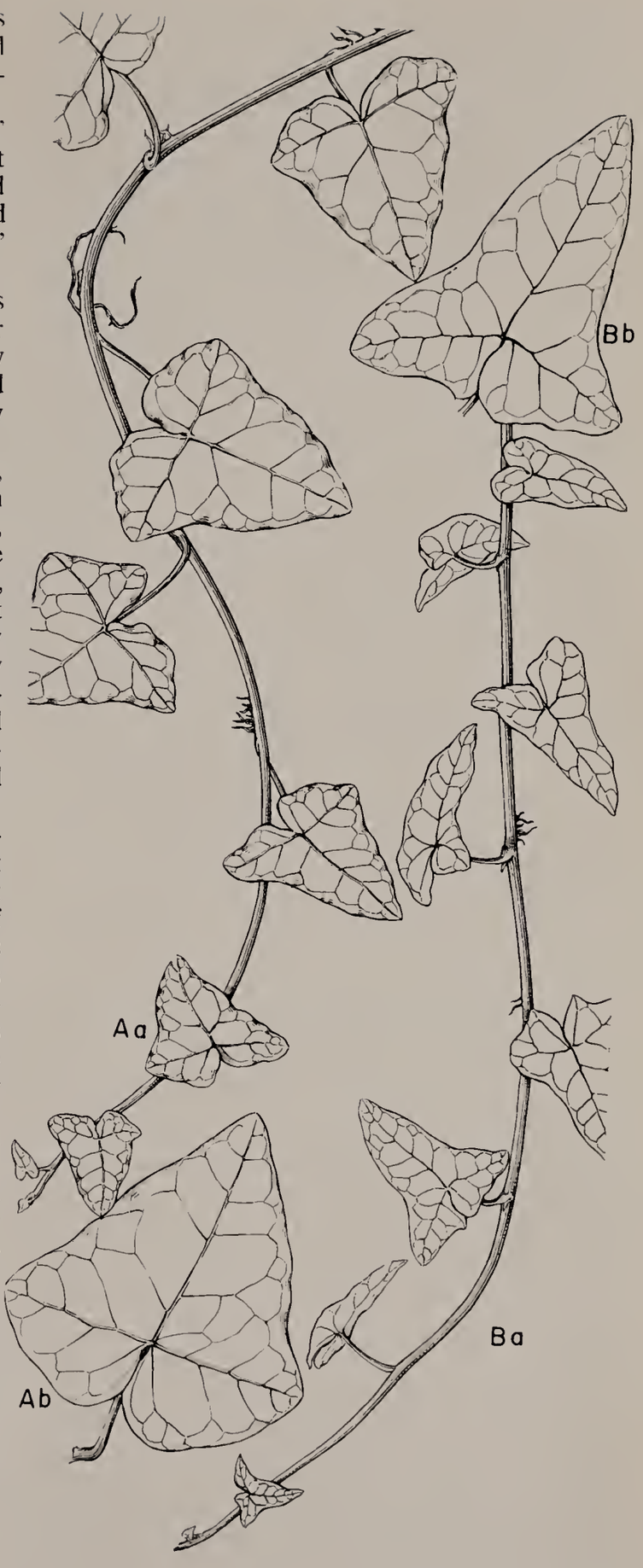



Fig. 14. *Hedera Helix* clones. A, 'Helvetica': Aa, branch × ½; Ab, leaf × 1. B, 'Sagittæfolia': Ba, branch × ½; Bb, leaf × 1.

green) and the older ones are bright green. The clone 'Smithii,' of recent introduction, is very similar, but is inferior as concerns extremes of foliage color. The clone 'Buttercup' is of this same alliance.

The other clones fall more or less into two groups: those with 3-lobed and those with 5-lobed leaves. The two most commonly grown are 'Glymii' and 'Scutifolia.' The second is variable in leaf form, with 5-lobed leaves as frequent as the 3-lobed. Cl. 'Deltoidea' is similar to both, but readily separated by the basal lobes of the leaves overlapping. Cl. 'Walthamensis' (known also as 'Minor') is the smallest leaved of the 5-lobed sorts and is a miniature form of typical English ivy, the two being distinctive by the white veins. The deeply lobed clones of 'Pedata' ('Birdsfoot,' 'Cænwoodiana'), 'Digitata,' 'Crenata,' and 'Minima' are unstable in leaf form, sometimes so much so that it is not possible to name a particular plant. This variability is more conspicuous among older outdoor plants than among pot subjects, where leaves of basal and lateral shoots are scarcely, if at all, distinguishable from those of typical English ivy.

There is in the trade a plant with small, dull dark green heart-shaped leaves, mostly ½-1 inch long, passing under the name *H. colchica minor*. The hairs, as well as leaf form and venation, place it in *Hedera Helix*. It is a diminutive form of 'Scutifolia,' differing only in the smaller leaves as noted in the key above. It appears to have no valid name and I here name it cl. 'Scutifolia Minor.'

The plant known in the trade as 'Bulgarian Ivy' appears to be indistinguishable from typical *Hedera Helix*.

Ivy clones with palmate or fan-shaped leaves are sometimes difficult to identify and name. One, with 5-7 shallow more or less equal lobes, and blades wider than long (see Fig. 12-C) has passed as 'Palmata' but is not that clone. Mr. Nilhaus Jensen, of the Copenhagen Botanic Garden, has given it the Danish name 'Den Gamle Have' of which the English equivalent is 'The Old Garden.' This Danish name is that of a well-known wholesale nursery and greenhouse situated at Frederiksdal pr. Lyngby—a surburb of Copenhagen. The variant occurs in variegated and non-variegated forms. It is here suggested that the name 'Old Garden' be used for the clone by English speaking people.

Group III is composed of those non-precocious clones whose leaves are variegated. It sometimes happens among individual plants that only a minority of the twigs, or of the leaves, show this variegation — a situation more common among older than younger specimens. The clones are considered to differ according to the characters of the following key. (Fig. 16)

1. Leaves variegated "white" along margins (mid-section may be mottled green and gray-green).

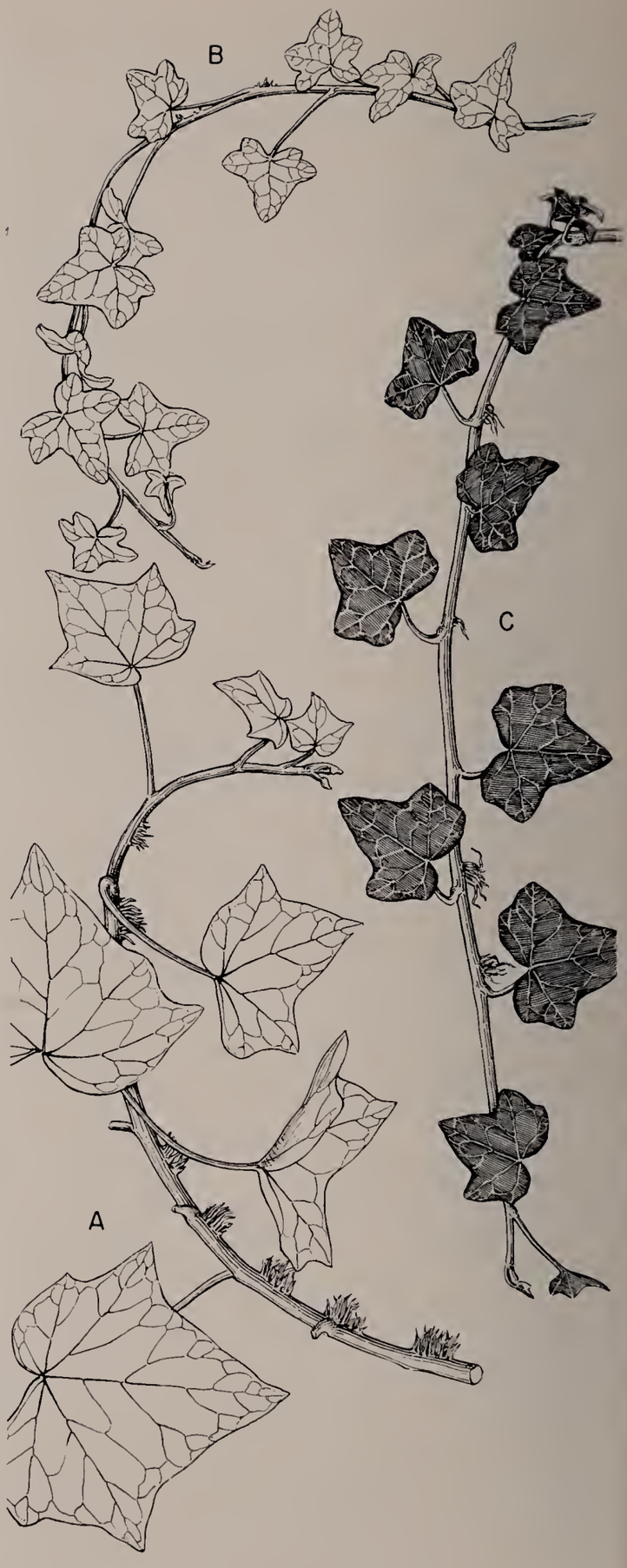



Fig. 15. *Hedera Helix*. A, var. *Helix;* B, var. *hibernica;* C, cl. 'Walthamensis'. All x ½.




Fig. 16. *Hedera Helix* clones. A, 'Discolor'; B, 'Cavendishii'. Both x ½.

2. Variegation present in all seasons of the year. . . . . 53. cv. 'Cavendishii'
2. Variegation consisting of an ivory-colored margin which during autumn and winter months (especially if grown outdoors) develops a purplish-red edge; petioles purplish-red (in autumn and winter). . . . . 54 cl. 'Tricolor'

1. Leaves variegated "white" over most of surface, or at least not along margins only.
   3. Variegation in form of small spots, flecks, or streaks.
      4. Leaves large, mostly 2½-4 inches across, the terminal lobe as broad as long. . . . . 55. cl. 'Maculata'
      4. Leaves small, mostly ¾-2 inches across, the terminal lobe somewhat longer than broad.
         5. Variegation in shades of ivory-white or pale cream-color. . . . . 56. cl. 'Discolor'
         5. Variegation butter-yellow in color. . . . . 57. cl. 'Gold Dust'

3. Variegation in form of one or a few patches or distinct zones.
   6. Leaves with yellowish-green area bordering midrib, the rest of the leaf bright to dark green.
      7. Petioles ¼-¾ inch long, internodes of axillary shoots to ¼ inch long. . . . . 58.cl. 'Merion Beauty'
      7. Petioles 1 inch long or more, internodes of axillary shoots mostly ⅝-1 inch long. . . . . 59. cl. 'Green Quartz'
   6. Leaves often entirely variegated when young or with many blotches.
      8. Terminal lobe larger than the lateral lobes. . . . . 60. cl. 'Aureo-variegata'
      8. Terminal lobe about same size as lateral lobes. . . . . 61. cl. 'Palmato-aurea'

The plants characterized by the "white-margined" leaves are treated here as belonging to the cv. 'Cavendishii.' Because it is highly improbable that all came from a single "ancestral" stock plant, it is improbable that they are propagules of a single clone. Plants in the trade under the names 'Glacier,' 'Silver Emblem,' and 'Silver Garland' are included here for lack of any apparent distinguishing characters, although in 'Silver Garland' the greens appear to be brighter than in 'Silver Emblem.' This is the plant Rehder designated var. *variegata* in his Manual.

Those plants with leaves flecked ivory-white or cream-color are usually 'Discolor' ('Marmorata'). The cl. 'Maculata' differs primarily in the longer and narrower terminal lobe. When grown in the open both clones are inclined to revert to the green-leaved type with the number of variegated leaves often reduced to a small minority.

## ARBORETUM ACTIVITIES

*(Continued from page 18)*

a few of the Kurume group. Against a background of conifers these fine azaleas should be seen to good advantage.

### Wisteria Walk

A new walk has been established leading from the Rose Garden down to the Lower Nursery, thus giving access to a section of the Arboretum seldom seen by visitors. Here, on a double row of black locust posts, has been planted a choice collection of Chinese and Japanese wisterias which have been held in the slat-house for several years. Altogether about 20 interesting varieties are included in this planting. This new allée is expected to produce a considerable effect this season and should become increasingly attractive as these plants mature.

### The Summer Course

The Bulletin in its issue for September 1955 carried an account of the course in Woody Ornamentals which was offered at the Arboretum during the summer of 1955. The purpose of this course was to familiarize students with the rich variety of native and exotic trees and shrubs represented in the collections of the Arboretum.

Since there is a continuing demand for this type of instruction, the course will be offered again this coming summer through the auspices of the Summer School of the University of Pennsylvania. It will begin on Monday June 25 and terminate on Saturday, August 4. Anyone interested in this program should communicate with the Director of the Summer School, 116 College Hall, University of Pennsylvania, Philadelphia 4, Pa.

### Recreation Area

As was the case last summer, the newly established Recreation Area, with facilities for picnics and outdoor games, will again be available without charge on an appointment basis. Although primarily intended for use by student groups from the campus, it may be used by other organizations who will submit their requests to the Dean of Student Affairs, Logan Hall, 36th and Woodland Avenue, Philadelphia 4.

J. M. F., Jr.

# Library Accessions

The following volumes have recently been added to the Arboretum Library:

*Climbing Roses,* Helen VanPelt (M. Barrows & Co., 1955)

*Shade Tree Pruning,* A. Robert Thompson (Tree Preservation Bulletin No. 4, U. S. Dept. of the Interior)

*Rope Knots and Climbing,* A. Robert Thompson (Tree Preservation Bulletin No. 7, U. S. Dept. of the Interior)

*Landscaping Your Own Home,* Alice L. Dunstan (Macmillan, 1955)

*Propagation of Horticultural Plants,* G. W. Adriance and F. R. Brison (McGraw-Hill, 1955)

*Bonsai,* Claude Chidamian (Van Nostrand, 1955)

*Water,* The Yearbook of Agriculture, 1955

*Plant Propagation Practices,* James S. Wells, Macmillan, 1955)

*The Arnold Arboretum Garden Book,* Donald Wyman (Van Nostrand, 1954)

*National Shade Tree Conference, 1954* (Collier Printing Co.)

*The Genus Phlox,* Edgar T. Wherry (Morris Arboretum Monograph No. III, 1955)

*American Men of Science, Vol. II, Biological Sciences* (The Science Press, 1955)

*Small Home Landscaping,* P. J. and A. B. McKenna (Arco Publishing Co., 1953)

*Small-Fruit Culture,* James S. Shoemaker (McGraw-Hill, 1955)

*Garden Design Illustrated,* J. A. and C. L. Grant (Univ. of Washington Press, 1954)

*Garden Spice and Wild Pot-Herbs,* W. C. Muenscher and M. A. Rice (Comstock Publishing Associates, 1955)

*Asiastic Magnolias in Cultivation,* G. H. Johnstone (The Royal Horticultural Society, London, 1955)

**American Rock Gardens,* Stephen F. Hamblin (Judd Publishing Co., 1929)

**Common Sense in the Rock Garden,* James H. Bissland (A. T. de la Mare Co., 1938)

**The Rock Garden,* Reginald Farrer (Frederick A. Stokes Co.)

*How to Grow Beautiful House Plants,* Thomas Everett (Arco Publishing Co., 1955)

*Vascular Plants of Illinois,* George N. Jones and George D. Fuller (Univ. of Illinois Press, 1955)

*The Propagation of Alpines,* Lawrence D. Hills (Faber and Faber, London)

*Climates in Miniature,* T. Bedford Franklin (Philosophical Library, Inc., 1955)

*Lexicon Dendrologicum,* Frans and Severin Amelinckx (De Sikkel, Antwerp, 1955)

*Northern Rocky Mountain Trees and Shrubs,* J. E. Kirkwood (Stanford University Press, 1930)

*Peru History of Coca,* W. Golden Mortimer (J. H. Vail & Co., 1901)

*The Rhododendron and Camellia Year Book 1956* (Royal Horticultural Society, London)

*How to Increase Plants,* Alfred Carl Hottes (A. T. de la Mare Co., 1949)

* Gift of Edgar T. Wherry

# Morris Arboretum Bulletin

SEPTEMBER, 1956

VOL. 7 NUMBER 3



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Mary O. Milton, *Propagator*
John Tonkin, *Superintendent*
James O'Neil, *Custodian*
Fred W. Schwoebel,
*Curator of the Langstroth Bee Garden*

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# Arboretum Activities

*Open House*

On Sunday afternoon, May 20, the Arboretum held the first Open House for its Associates and neighbors. This date was selected to coincide with the optimum blooming period of our main Azalea plantings and the occasion, favored as it was by superb weather, proved a memorable one.

Some 200 persons attended this function and partook of refreshments served on the porch of the Morris Mansion. Guided tours under competent leaders set out at regular intervals to visit the Azaleas and other groups of plants.

Members of the Advisory Council, under the chairmanship of Mrs. E. Florens Rivinus, served as hostesses to welcome our guests. The enthusiastic response to this occasion would seem to indicate that such an Open House should become an annual feature of the Arboretum's activities.

*Recreation Area*

Thirty-eight groups have held outings at the Arboretum's Recreation Area since April 20 of this year. Among the organizations to take advantage of this service were all four classes from the

*(Continued on page 39)*

# The Story of the Cultivated Horse-chestnuts

Hui-Lin Li

## Introduction

Among shade trees, Horse-chestnuts and Buckeyes have a special appeal because of their very striking foliage and flowers. The large plamately compound leaves are unique among trees of the temperate regions. The long upright clusters of colorful flowers are showy and conspicuous. These, together with the stately, compact pyramidal shape make them among the most popular ornamental trees in all continents of the northern hemisphere.

Most people consider the trees to be magnificent in both foliage and flowers. Wilson (1920), for instance, speaks enthusiastically of the Common Horse-chestnut as the most handsome exotic flowering tree in the Eastern United States. But dissenting view is sometimes also expressed such as by Wyman (1951) who considers the tree coarse in foliage texture, flower, and fruit and a "dirty," one, as it is always dropping something.

## The genus Aesculus

The Horse-chestnuts and Buckeyes belong to the genus *Aesculus,* of the Hippocastanaceæ or the Horse-chestnut family, a genus of some 15 species of trees or shrubs of the temperate regions of the northern hemisphere. The leaves are oppositely arranged, each with 5-9 digitately disposed leaflets. The flowers are 4-5 petaled, white or showy-colored, and are borne in upright many-flowered clusters. The fruit is large, rounded, either smooth or prickled outside, splitting into 3 valves exposing the single large seed. The seed or nut is unfit for human consumption.

Native species are cultivated in Europe and Asia and also in North America. The bringing together of European and American species in cultivation, and the several different American species themselves, has resulted in the production of many hybrids, some superior to the parental species in certain qualities. The very l: ge number of hybrids which have arisen in cultivation within the last 200 years renders this group a distinctive one in the genetics of trees and ornamentals. The significance of hybridity in this genus is further enhanced by the occurrence of chromosome doubling in certain forms, which renders these fertile and true-breeding and leads to the production of hybrids with intermediate chromosome numbers between the low and high chromosome-types. The story of hybridization in the genus *Aesculus* is documented by cytological studies and well illustrates what can be done in deliberate breeding of trees in many families and genera.

## European species

The Common Horse-chestnut, *A. Hippocastanum,* native to the Balkan peninsula, is the only European species of the genus. It is a large tree, attaining a height of 100 feet, with 5-7-foliolate leaves, sessile leaflets, white flowers tinged with red and prickly fruit. It is the first of all shade trees to burst into leaf, and it is desirable not only as a street tree but also as a specimen tree in parks or private grounds.

In Europe and in England it is now widely planted and becomes such a common feature of the landscape that most people take it for granted that it is native. In England, the most famous planting is the avenue leading to the Hampton Court Place at Bushey Park on the bank of the Thames, a mile in length and 170 feet wide, and lined with 137 trees on each side set 42 feet apart. It was planted by the famous architect Sir Christopher Wren in 1699. The tallest trees are over 100 feet high and the show of blossom is truly spectacular. (Wilson 1920)

The native home of this species was long an enigma to botanists. Linnaeus considered the tree indigenous to northern Asia and DeCandolle thought that it came from northern India. Only Decaisne expressed the opinion that the plant was of European origin and this was confirmed, and the enigma finally solved by the discovery made by Orphanides of the tree growing in a wild state in the mainland of Greece (in a note in the French translation of Griesbach's Die Vegetation der Erde, made by M. de Tchihatschef, 1876). It is now definitely established that its native habitat is confined to northern Greece and Albania. Its occurrence in other regions is in all cases due to cultivation.

It is uncertain whether or not the Horse-chestnut was known to the ancient Greeks. The earliest record of cultivation is in Constantinople. The fruit was known as At-Kastan (Horse-chestnut) to the Turks who found them useful as a drug for horses suffering from broken winds or coughs (Loudon 1838, Wilson 1920).

Seeds of the Horse-chestnut were sent in 1570 from Constantinople to Vienna by Dr. von Ungnard, Imperial Ambassador to the court of Suliman II, and a tree was raised by the celebrated botanist Clusius. Seeds were brought to France from the Levant by Bachelier in 1615, and the tree was probably introduced into England at about the same time. (Loudon 1830).

Although the exact dates of many plants introduced into this country by early English settlers are

so often unknown, fortunately, as noted by Wilson (1920), the introduction of the Common Horse-chestnut into America is a matter of record. The exact date is noted in the letters published by William Darlington in his *Memorials of John Bartram and Humphrey Marshall,* in 1849. Seeds were first sent by P. Collinson in 1741 from London to John Bartram in Philadelphia and in 1763 Collinson learned of the flowering of his introduced Horse-chestnut. Collinson spoke also of the long Horse-chestnut avenue at Hampton Court( the trees were then 50 feet high), as "one of the grandest and most charming sights in the world". In recording this introduction, Wilson especially remarked that, based on his own experience, he considered the Horse-chestnut among the most difficult to transport safely and he marveled that in those days on slow sailing ships its introduction into the New World should have been successfully accomplished.

The Common Horse-chestnut is now widely planted and there are numerous garden forms which have originated in cultivation. There is a double-form 'flore pleno'. In leaf variations, there is 'Memmingeri' with yellow leaves, 'aureo-variegata' with yellow variegated leaves, 'laciniata' with narrowly lobed leaflets, and 'crispa' with stalked and broad leaflets. In habit 'pyramidalis' is upright, 'umbraculifera' is dense and globular, and 'tortuosa' has bent and twisted branches. All these garden forms are propagated by cuttings or grafting and are thus to be considered as clones.

### Himalayan and Southern Asiatic Species

There are two species of *Aesculus* native to the Himalayan region and southern mainland Asia. One of them, the Indian Horse-chestnut, *A. indica,* a large tree to 150 feet high, is a common tree in the northwestern Himalayas from the Indus to Nepal, and also in Afghanistan. It occurs at elevations from 4,000 to 10,000 feet. The seed is given as food to cattle and goats, and, ground and mixed with ordinary flour, is also part of the diet of the hill tribes. (Elwes and Henry 1907). The tree is occasionally cultivated in England but it does not seem to have been introduced into North America.

Another species, *A. punduana,* occurs in the northeastern India, in Sikkim and Khasia Hills through Upper Burma, Thailand to Tonkin in Indo-China. It is a large tree with very large leaflets. Essentially a sub-tropical tree, it is not cultivated elsewhere.

### Eastern Asiatic Species

Three species occur in eastern Asia: two in China and one in Japan, all of them occasionally known in cultivation in other temperate regions. Although the three species are distinct both morphologically and geographically, they have been much confused with each other in botanical as well as pre-scientific writings.

In northern and eastern China, the Chinese Horse-chestnut, *A. chinensis,* is widely grown as a shade and ornamental tree, especially on the grounds of Buddhist and Taoist temples. The tree is probably native to Shansi and Shensi in northern China and the present range is much expanded because of cultivation.

The Chinese Horse-chestnut is a medium-sized tree attaining a height of 75 feet. The leaves are composed of 5-7 large and stalked leaflets. The flowers are white and small, forming panicles about 8 inches long. The generally globular fruit is about ¾ in. across, more or less depressed above, and covered with warts but is not spiny.

In western China, in Szechuan and Hueph, there occurs a Horse-chestnut originally regarded as belonging also to *A. chinensis,* but Rehder (1913) separated it as a distinct species, *A. Wilsonii.* It is very similar to *A. chinensis* in general appearance, differing mainly in its hairy and longer-stalked leaflets, in its larger flowers, and in the more rounded fruit with larger seeds. It is a tree of the mountains, occurring in woods at elevations of 3000-6000 feet.

In Japan, there is found *A. turbinata,* which was formerly much confounded with the Chinese Horse-chestnut. The Japanese Horse-chestnut has stalkless instead of stalked leaflets and 5 instead of 4 petals. The flower is yellowish-white and the fruit is broadly pear-shaped. This tree is cultivated in Japan and also in some cities in eastern China.

In China *Aesculus* is often called Seven-leaved Tree, referring to the palmately compound leaves, or sometimes as Monkey-chestnut because of its original mountainous habitat and of the fruit unfit for human consumption.

A special significance is attached to the Horse-chestnut in China and Japan by the Taoists and the Buddhists. In the hills around Peking, and in many other parts of China, the tree is frequently planted on temple grounds which the Buddhist monks call So-lo. This is a transliteration of a Sanskrit name "Sala," which originally refers to *Shorea robusta* of India, one of the sacred trees of Buddhism. In a grove with a mighty "Sala" tree, the Buddha Guatama, founder of Buddhism, was born, his mother clutching a branch of the mighty tree. An even greater sanctity was given to this species because Guatama on his last mission died, lying on his cloak, which his disciple Anada folded and placed for him on the ground between two "Sala" trees (Burkhill 1946).

As *Shorea* is not hardy in northern China, Buddhists anxious to grow the tree about their establishments transferred the name to *Aesculus,* an attempt, as Burkhill says, made in a kind of desperation. Burkhill thinks that it is remotely possible that this substitution began in Kashmir monasteries

when, in their inability to grow *Shorea,* the monks substituted the Indian Horse-chestnut, *A. indica,* but he says this is not actually demonstrated. Thus, Burkhill asserts that "The Chinese, whose pilgrims were certainly familiar with Kashmir, for some unexplained reason took their *Aesculus chinensis* Bunge, which is very like *A. indica,* for 'Sala,' calling it 'So-lo,' planting it about their monasteries."

However, the substitution of the name is entirely of Chinese origin, and as noted by Burkhill, it is not concerned with the Kashmir plant. The reason for choosing this plant, which puzzles Burkhill, is to be found in the religious significance attached to the plant in China prior to its adoption by the Buddhists apparently only since the 16th century.

In China, *Aesculus* is also known by the name Tien-shi-li, or "Chestnut of the Heavenly Teacher"; this name appears first in the book, "Account of the products of Szechuan," by Sung Chi of the 11th century. It states that the tree is found only in the Ching-chen mountains of Szechuan and was reputed to be planted there by Tien-shi, the Heavenly Teacher, referring to the Taoist pope, Chang Tao-ling of the first century A.D., when he studied and meditated there, seeking for "Tao," or the truth. From the locality, apparently the name refers more specifically to *A. Wilsonii.*

Li Shi-chen, in his great herbal Pen Ts'ao Kang Mu of 1558, identifies this Tien-shi-li with the plants called So-lo, a name which he says was unknown in former times. Thus it is clear that the Buddhists adopted this plant almost five centuries after the Taoists attributed any significance to it.

Along with these attributions, the seeds of *Aesculus* were reported to have benign influence in exorcising demons. The transference of the sacred Buddhist tree "Sala" from *Shorea* of India to *Aesculus* in northern China, out of necessity because of climatic incompatibility, is thus apparently motivated by its original religious and superstitious significance.

## American Species

There are no less than 10 species of *Aesculus* in North America, the largest concentration of the genus. These species, generally known as Buckeyes in America, are usually smaller trees or shrubs. They have mostly 5 leaflets.

Among the larger species, trees or sometimes large shrubs, there are about 7 species. There are two species in California, *A. Parryi* and *A. californica.* The latter, the California Buckeye, the more common species, is a tree 35 feet high and with white to rose-colored, fragrant flowers. It is in cultivation but suitable only for the southern states.

The largest American species is the Sweet Buckeye, *A. octandra* of eastern North America. It grows to a height of 90 feet, and bears flowers which are usually yellow. Another large tree is *A. sylvatica (A. neglecta),* native from North Carolina to Alabama, which attains a height of 60 feet, with pale yellow flowers.

Among the smaller trees is the Ohio Buckeye, *A. glabra,* state tree of Ohio, a tree to fifty feet tall with relatively small and bright red flowers. Another shrub or small tree of the same stature is *A. discolor* of the southern states, which bears yellow flowers flushed with red.

Among the species mentioned above, the most commonly planted ones are the Ohio Buckeye and the Sweet Buckeye. These two species have also been introduced into England and the European continent and are frequently planted there.

The remaining species are mostly shrubby. Among them are some valuable ornamentals for the lawn, such as *A. parviflora* and *A. splendens,* of the southeastern and the southern states respectively. The latter is a spreading shrub readily propagated by root-cuttings, and is especially valuable for its autumn flowers of a very beautiful red color.

*Aesculus parviflora,* which is known as the Bottle-bush Buckeye, is a shrub 3 to 10 feet tall, with white flowers and long exserted stamens. (See cover)[1] The plant spreads rapidly by horizontal runners and a single specimen may, in a few years, cover an area of many square yards. Several fine examples of this species may be seen on the grounds of the Arboretum. (Fig. 17)



Fig. 17. *Aesculus parviflora*

## Hybrids

The number of hybrids or putative hybrids are, in proportion to the number of species, exceedingly large in the genus *Aesculus.* The exact origins of most such hybrids are not known. Some occurred in the wild, but the majority originated in cultivation.

[1] All photographs in this issue by Dr. E. J. Schreiner.

The Common Horse-chestnut of the Balkans was first introduced into France and England in the first half of the 17th century and into North America in the 18th century. The American species have been in cultivation since the latter part of the 18th century. As early as 1764 the American Sweet Buckeye, *A. octandra,* was introduced into England, and the Ohio Buckeye, *A. glabra,* was introduced in 1812. (Loudon 1838). Many species or varieties of American origin, however, did not occur in cultivation until the beginning of the present century. Thus, the numerous hybrids of the genus could not have appeared in cultivation, either in this country and in Europe, before the latter part of the 18th century, and actually many of the hybrids were noted only in the last 50 years.

A large number of hybrids are recorded as crosses among the American species, but the most celebrated hybrid is the Red Horse-chestnut, *A.* × *carnea,* supposedly a cross between the European *A. Hippocastanum* and the American *A. Pavia.*

This plant must have originated before 1818, the year Loiseleur, who first described the plant as *A. rubicunda,* received it from Germany, but as there are no earlier accounts of it, the exact origin is unknown. However, it was long considered as undoubtedly a chance hybrid between *A. Hippocastanum* and *A. Pavia,* as it possesses characters of both the supposed parents. Among the characters derived from the former are the leaves and the slightly spiny fruits. Characters derived from the latter are the color of the petals and the glands on their margins. The Red Horse-chestnut is a small tree usually about thirty feet in height. The flowers are red, with an orange blotch at the base of the petals which eventually become deep red.

Unlike most other hybrids, this plant breeds true from seed. This peculiarity, together with its hybrid nature, was later revealed by cytological studies. Hoar (1927) discovered that *A.* × *carnea* has 80 chromosomes while all the other species of the genus, including the two supposed parents, have 40. Thus this plant is a tetraploid, a plant with a double set of the normal diploid chomosome apparatus.

*Aesculus* × *carnea* was therefore presumably derived by the doubling of a sterile hybrid, which explains its capacity for breeding true from seed. This doubling of chromosome number was confirmed by Upcott (1936), who also found the chromosomes of the two parent species exactly similar in size and shape. These parent species, having 40 chromosomes, show secondary pairing and the formation of an occasional quadrivalent, a phenomenon suggesting that the parent species themselves are tetraploids and that the normal chromosome number of the genus is 20. The hybrid *A.* × *carnea* must therefore be regarded as an octoploid, a plant having a double chromosomal apparatus of a tetraploid.

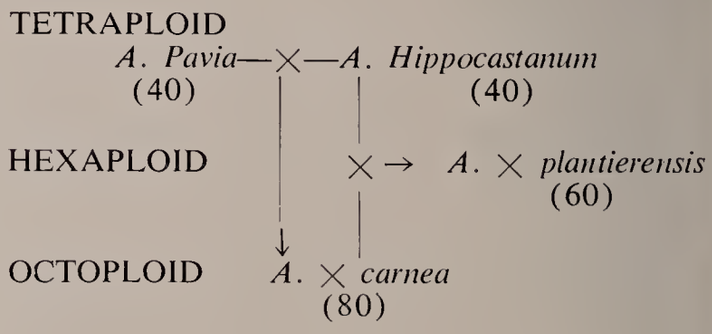
The leaves of *A.* × *carnea* are of a darker green than ordinary, of a firmer texture and with an even surface, and the short-stalks of the leaflets are more or less curved and twisted. These characters are attributable to the polyploidal nature of the plant, a plant having more than the normal diploid number of chromosomes. Its ability to resist drought better than the parent species is apparently also due to its hybrid nature.

The most interesting fact about hybridity in *Aesculus* is the occurrence of another hybrid, *A.* × *plantierensis,* a chance hybrid supposedly between *A. Hippocastanum* and *A.* × *carnea.* This plant was raised in the nurseries of Messrs. Simon-Louis Frères at Plantiéres near Metz, France, from a seed of *A. Hippocastanum* (André 1894). It is intermediate in characters between the two supposed parents. It has whitish flowers suffused with pink and fading to pink.

This supposition that *A.* × *plantierensis* is a back cross of an octoploid progeny to one of the tetraploid parents was later confirmed by Upcott (1936). He found the chromosome number to be 60, and therefore the plant is to be regarded as a hexaploid. This plant is a sterile one with its chromosomes consisting of varying numbers of univalents, bivalents, and multivalents.

This plant is also considered as a variety of *A.* × *carnea* as "var. *plantierensis*" (Rehder 1940). As its hybrid nature is definitely established, it will be more appropriately designated as *A.* × *plantierensis,* the name originally proposed for it by André.

The relationship and parentage of the several plants in consideration, illustrating as it does a most unique and striking case of hybridization, backcrossing and chromosome doubling in trees, can be summarized by the following diagram:




Among the numerous hybrids of garden origins between the American species, the most notable is the Hybrid Buckeye, *A.* × *hybrida,* a hybrid between *A. octandra* and *A. Pavia,* which originated before 1815. Its characteristics are intermediate between the two parental species. There

are several forms of this hybrid in cultivation with the color of the flowers varying from yellow slightly tinged with pink to nearly red throughout.

Many other hybrids have been cultivated since the beginning of the present century from plants which originated either in the garden or in the wild. In Rehder's Manual (Rehder 1940), there are listed 15 species of cultivated *Aesculus* and no less than 16 hybrids or supposed hybrids of known as well as unknown origins.



Fig. 18. An unusually handsome *Aesculus* of unknown origin.

On the ground of the Morris Arboretum there grows an unusually handsome *Aesculus* of unknown origin which may possibly be a new hybrid between *A. glabra* and *A. Hippocastanum,* as it shows characters intermediate between the two. The tree is especially notable because of its admirable form, dense branching, and thick non-shedding foliage which is of an excellent bright green turning a brilliant red in fall (Fig. 18). Particularly outstanding is the resistance of this foliage to leaf blotch disease, which browns the leaves of most species of *Aesculus* during the summer months, often rendering the trees unsightly. (Skinner 1949).

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## ARBORETUM ACTIVITIES

*(Continued from page 34)*

School of Medicine, several fraternities and campus clubs and the faculties and graduate students of a number of schools and departments.

So popular has been this feature of the Arboretum's facilities that it is planned to double the size of the area for next year. Members of the Sphinx Senior Society have undertaken the construction of a new stone fireplace.

### *The Summer Course*

For the second consecutive year the Arboretum offered a six-week course on Woody Ornamental Plants under the auspices of the Summer School of the University of Pennsylvania.

Of the eighteen students enrolled, eight were members of the graduate program in Landscape Architecture in the School of Fine Arts. The remainder were either high-school teachers of biology or persons interested in becoming acquainted with the important native and exotic trees, shrubs and woody vines which are hardy in this area.

As was the case last year, the study material was drawn from the rich resources of the Arboretum. Daily trips around the grounds enabled the students to study the living plants and thus to supplement the knowledge gained by identifying specimens in the laboratory.

In all some 500 species, belonging to about 200 different genera, of woody plants were covered and the members of the class made their own permanent collections for future reference.

*(Continued on page 42)*

# Albizzia

J. M. Fogg, Jr. and Hui-Lin Li

The genus *Albizzia,* while of frequent occurrence both in the wild and in cultivation throughout the tropics, is seldom seen in the north temperate regions. Most of its species may be regarded as horticultural gems, with highly distinctive ornamental qualities. Among their desirable features are their gracefully spreading branches which form a low broad crown (Fig. 19), their delicate, feathery compound leaves, (Fig. 20) the exquisite, silken tassel-like nature of their flower clusters, (Fig. 21) and their unusually free and prolonged habit of flowering.



Fig. 19. *Albizzia julibrissin,* var. *rosea*

Botanically *Albizza* is interesting because it is the only genus of the subfamily Mimosoideae of the large Pea family that can be grown in the northern temperate climate. The Pea family or Leguminosae is divided into three subfamilies, Mimosoideae, Caesalpinioideae, and Paplionioideae, sometimes considered as three distinct families. The



Fig. 20. *Albizza julibrissin,* var. *rosea,* foliage and flower clusters.

Mimosoideae, the most primitive group of the three, differ from the others in having flowers with regular valvate petals and five to many stamens. It is almost exclusively tropical and subtropical in distribution.

Among the Mimosoideae, the genus *Albizzia* is most closely related to *Acacia,* a tree of common occurrence in tropical regions. The primary difference between the two lies in the stamens which are free in *Acacia* and united at the base in *Albizzia.*

The genus *Albizzia* includes some 25 species distributed in tropical and subtropical Asia, Africa, and Australia, with two in Mexico. They are deciduous trees or shrubs with bipinnate leaves, the leaflets being usually small and numerous. The often fragrant flowers are produced in stalked clusters, each with a small tubular 5-toothed calyx, a small corolla with the valvate petals united below, and with numerous long exserted stamens usually more or less connate at base. The calyx and corolla are usually whitish but the long stamens are often colored pink or yellowish which give the color to the flowers and flower-clusters. The regular flowers of *Albizzia* are thus very different from the typical paplionaceous or butterfly-like flowers of the Pea family in the temperate regions, but the large strap-



Fig. 21. *Albizzia julibrissin,* var. *rosea,* foliage and flower clusters.

shaped pod, similar to the fruit of all other leguminous plants, at once proclaims its kinship.

Among the many species of the genus, only two have their natural ranges in temperate regions in eastern Asia. *Albizzia julibrissin* occurs in Asia from Iran eastward to central China and Japan. This is a small tree with pink flowers. The leaves have 10-25 pinnae each with 40-60 small leaflets. Another species, *A. Kalkora,* occurs from eastern to central China, Indo-China and India. It is also a small tree but with whitish flowers. The leaves have 4-12 pinnae, each with 10-28 leaflets. This tree was formerly much confused with *A. Lebbek,* the Siris Tree or Lebbek Tree, of tropical Asia and northern Australia, a species frequently planted as a yard tree in the American tropics. *A. Lebbek* differs from the former primarily in the greenish yellow flowers and much longer pods.

The two species are now widely cultivated in tropical and subtropical countries all over the world, but they are also hardy in warmer temperate regions and can be grown in North America as far north as Washington, D. C. and the southern part of New Jersey along the eastern seaboard. *Albizzia julibrissin,* with its more finely divided leaves, is more graceful in appearance and more generally planted, while *A. Kalkora* is still relatively rare in cultivation. Moreover, *A. julibrissin* has a hardier variety, var. *rosea,* of smaller stature than the typical form and with brighter pinkish flowers. This species can be grown in the eastern United States as far north as Massachusetts.

*A. julibrissin,* generally known as the Silk Tree, is now a common plant in the southern part of the United States where it is often escaped and widely naturalized. But the hardy variety, valuable and interesting as it is, is not widely planted in the north.

Like other species of *Albizzia,* the Silk Tree is highly ornamental. The slender trunk has a smooth pale gray bark. The large, finely divided, feathery leaves and the showy clusters of silken flowers create a truly tropical effect in landscaping. The small stature and the wide-spread crown make this tree especially desirable to match the low type of houses now so prevalent.

This low stature, together with the slow growing habit, makes this tree a highly commendable one for street planting in suburban areas. There is little possibility in damaging by overhead utility wires in storms. The wide-spread crown covers a great area and yet the shade is not dense. In the summer, the showy flowers, usually lasting from late June to mid-September, present a sight unsurpassed by any other tree.

The *Albizzia* are sometimes known as "Mimosa Trees" because of their resemblance to *Mimosa,* the Sensitive Plant. The leaves and leaflets in *Albizzia* are also sensitive but they do not respond instantaneously to touch and other stimulations as is the case in most species of *Mimosa.* They are, however, sensitive to light and the leaflets close slowly at dusk and open up again in the morning. Also, in *Mimosa* the number of stamens equals or is double that of the petals, whereas in *Albizzia* the stamens are more than twice as many as the lobes of the corolla.

Propagation of *Albizzia* can be readily effected by seeds or by cuttings from half-ripened wood. The tree is also of easy culture as it grows well in a variety of soils. It thrives best in sunny and moist places but grows well also in relatively dry situations. *A. Kalkora* is a fast grower and a taller tree, attaining to a height of 55 feet. *A. julibrissin* is a slow growing tree with a height of about 35 feet, while the hardy variety *rosea* is lower and attains to a height of only 20-25 feet. There is a fine specimen of var. *rosea* in the Arboretum located on the northern side of the Rose Garden (Fig. 19). While in bloom during July and August this tree attracts considerable attention and the numerous comments we have received concerning it have impelled us to make plans for distributing seedlings to our Associates in the near future.

At the home of the senior author in Mt. Airy are two plants of var. *rosea,* now about 16 years old and some 25 feet tall. Careful records have been kept of their blooming dates and it is of interest to note that the average date of appearance of the first flowers is June 28 and that they bloom continuously until about September 15.

# Book Review

CHINESE FLOWER ARRANGEMENT, by H. L. Li. Hedera House, Box 4315, Philadelphia 18, Pa. 1956. xii + 122 pages. Illustrated. $4.00.

Associates of the Morris Arboretum may secure copies at the special rate of $3.50.

At the very start of this book, one learns that in China, flower arrangement is not a hobby or even a specialized study; it is an integral part of the culture of an old civilization. An arrangement of flowers in the hallway or study of a Chinese house is not only carefully planned to harmonize with surrounding accessories, the season, and the occasion, but is also steeped in symbolic meaning. For instance, the straightness of bamboo becomes symbolic of straightforwardness in life and the full bouquet of flowers can be used to celebrate hopes fulfilled. Dr. Li gives a detailed account of the various trees and flowers used for arrangements, according to the season when they are available. Many are familiar to us here but the mainstay of winter arrangements, the Japanese Apricot *(Prunus mume)* is not often seen.

The title is misleading, for far more is covered than what Dr. Li calls "vase arrangement." There is a full discussion of table culture or miniature gardening, more familiar to us in its Japanese form of Bon-sai, an art that is fascinating to the impatient occidental. Plants used for dwarfing are listed and cultural methods are described.

Students of ceramics and metal craft will be interested in the chapter on receptacles, the designing and making of which are yet another of China's contributions to the art of the world. A number of good illustrations help to show the intricate and delicate beauty of these vases and bowls.

Dr. Li's book deserves the attention of any reader who has an interest in plants or flowers indoors. He knows his subject well and the book has the ring of authenticity. His style, which I find charming, may be too formal for some readers. This, however, should not deter them from using this book as a reference.

The task of explaining flower arrangement as an art form is not easy, nor can a method of artistic expression that has evolved over centuries be fully understood by westerners contemplating it for the first time. For me, Dr. Li has opened the door to a world of new ideas. He has given me a glimpse of a different concept of the use of plants and flowers for interior decoration.

Ernesta Ballard
August, 1956

## ARBORETUM ACTIVITIES

*(Continued from page 34)*

In addition to learning to recognize the species studied in this course, the students received instruction concerning their horticultural value and ecological needs. Attention was given to the basic problems of plant breeding and to the methods whereby woody plants are propagated.

### *Staff and Personnel Changes*

During the past year the Arboretum has experienced a number of changes in staff and personnel. In January we lost the services of a valuable staff member, Martha H. Starr, our Propagator. Mrs. Starr resigned to devote her entire attention to an increasing family. However, we have been fortunate to secure in her place Miss Mary O. Milton, a graduate of the Pennsylvania School of Horticulture at Ambler. Miss Milton was with us part-time from February until July when she was appointed a full-time member of the staff.

John Dourley, a native of Scotland, has accepted the newly created position of Assistant Superintendent of Grounds. Mr. Dourley is unusually well qualified for this post, having received his training at the Royal Botanic Garden in Edinburgh, where he was subsequently employed as Gardner, and having also worked in conjunction with the Botany Department of the University of Edinburgh.

Another new position, Assistant Custodian of Buildings and Machinery, has been filled by the appointment of Henry J. Burns. Mr. Burns was recently promoted from the hourly payroll to this responsible post on the regular grounds force.

Two young men whom the Director met in the course of his travels in India have come to the Arboretum for a year's stay. Dr. P. D. Varadarajan of the Botany Laboratory of the University of Madras is here on a post-doctoral research grant, and Mr. P. V. Rajappan, who was employed in the Agricultural Department of the Government of Madras, is working as a gardener with special duties in the greenhouses.

The Arboretum mourns the loss of its Label Maker and Mechanic, George H. Campbell. Mr. Campbell died last May after having been with the Arboretum for thirteen years. His friendly personality, as well as his skilled services, are sadly missed.

# New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since last September:

Mrs. H. Paul Abbott
Dr. Francis Adler
Dr. Henry B. Allen
Mrs. F. Edward Atkins, Jr.
Mrs. Charles C. Bachman
Mr. Clifford J. Backstrand
Mrs. Robert L. Bast
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Mrs. Francis B. Crowninshield
Mrs. Elliot Daland
Miss Eleanor W. David
Miss Eleanor B. Davis
Mrs. Helena Day
Mr. and Mrs. Robert Dechert
Mrs. William F. Delafield
Miss Meribah Delaplaine
Dr. and Mrs. Charles Q. DeLuca
Mr. William E. Denk
Mrs. R. Meyer de Schauensee
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Mr. Howard Detweiler
Mrs. Antelo Devereux
Mrs. John H. Dilks
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Mrs. Benjamin Dintenfass
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Mrs. Lawrence Drake
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Mr. Carl A. Erikson
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Mrs. Hugh W. Field
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Mrs. Caleb F. Fox
Mr. and Mrs. John L. Frey
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Dr. and Mrs. Gaylord P. Harnwell
Mrs. Flagler Harris
Mrs. Alexander Hemphill
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Mrs. Albert Atlee Jackson
Miss Mabel Steele Jones
Mrs. T. Carrick Jordan
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Mrs. Morris Wolf
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# Morris Arboretum Bulletin

DECEMBER, 1956

VOL. 7 NUMBER 4



*Picea orientalis*

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# Arboretum Activities

## MICHAUX QUERCETUM

Previous issues of this Bulletin[1] have carried accounts of the Michaux Quercetum, a project jointly sponsored by the Arboretum and the Northeastern Forest Experiment Station of the U.S. Department of Agriculture and supported in part by a grant from the Michaux Fund of the American Philosophical Society.

Briefly, this undertaking is concerned with the growing and study of as many different species of oaks as will prove hardy in the Philadelphia area. To this end we have enlisted the cooperation of collectors throughout this country and abroad and to date 255 seedlots have been received, repre-

[1] Vol. 5:54-57, 1954. Vol. 6:45-48, 1955.

*(Continued on page 57)*

# An Illustrated Key to the Genera of Conifers

Hui-Lin Li

The following artificial key is prepared to provide a ready means of identifying the genera of conifers, native as well as cultivated, by leaf specimens only. In nearly all manuals of trees and shrubs the keys use both vegetative and reproductive characters; thus it often proves impractical to identify any plant without complete material. Reproductive features are here used only occasionally as a supplement to vegetative characters.

The key includes all genera native to and cultivated in the United States. A few genera not hardy in the Philadelphia area and farther north are marked with an asterisk (*). As few technical terms as possible are employed; thus an amateur botanist will be able to use it without consulting a botanical glossary. To explain more explicitly and graphically certain points that usually confound one in identifying some of the genera, a number of sketches and diagrams are given, which can be consulted when using the key.

The term "conifers" is here used in the broadest sense to include both true conifers and taxads. The taxads are generally distinguishable from the true conifers in that the ovules are solitary or few and these do not organize into "cones," which give the name to the conifers. With the exception of *Podocarpus, Cephalotaxus, Taxus,* and *Torreya,* all genera listed below are true conifers.

A very brief summary of each of the genera follows the key. These genera are listed alphabetically by their scientific name, followed by their respective common name. It should be noted that many of the common names are the same as the scientific names and that it is the general tendency in both botany and horticulture to use more and more scientific generic names as common names, not only among conifers but among other plant groups as well. For instance, *Cephalotaxus* is known as Plum-Yew, but Cephalotaxus is now also gaining in general usage to replace Plum-Yew as a common name.

The key has been used and tested at various times and occasions, among which are the classes in the course on "Woody Plant Material" which was conducted at the Arboretum during the past two summers. Suggestions for further improvements from others who may use it are sincerely solicited.

A. Leaves linear, flat or angular, or needle-like.
  B. Leaves in clusters or whorls.
    C. Leaves linear, large and flat, 5-12 cm. long and about 3 mm. wide, arranged in whorls of 10-30. — *Sciadopitys*
    CC. Leaves needle-like or linear, to 3 mm. or less wide, in whorls or clusters.
      D. Leaves needle-like or scale-like, in whorls of 3 or clusters of 2-5.
        E. Leaves 2, 3 or 5 in a cluster, very slender, 2.5 cm. or more long; cones large, dry. — *Pinus*
        EE. Leaves in whorls of 3, needle-like or scale-like, short and stiff, to 2 cm. long, usually much shorter; cones small, fleshy or woody.
          F. Leaves needle-like, to 2 cm. long, usually much shorter, in whorls of 3 or clusters of 2-5; cones fleshy, berry-like. — *Juniperus*
          FF. Leaves scale-like, 3 mm. long, in whorls of 3; cones woody. — *Fitzroya**
      DD. Leaves mostly linear or flattened, or sometimes needle-like, 10 or more clustered on short lateral shoots. (Fig. 19).
        E. Leaves deciduous, linear, mostly flattened, soft.
          F. Short lateral shoots longer, club-shaped, with distinct annual rings; bud-scales persistent, acuminate; leaves wider, to 2 mm. broad; cones breaking up when ripe. — *Pseudolarix*
          FF. Short lateral shoots shorter, cylindrical, with less distinct annual rings; bud-scales deciduous, obtuse; leaves narrower, to 1.5 mm. wide; cone-scales persistent. — *Larix*
        EE. Leaves evergreen, needle-like, pointed, rigid. — *Cedrus*
  BB. Leaves not in clusters but opposite, alternate or spirally arranged.
    C. Leaves needle-like or awl-shaped, spirally arranged or opposite.
      D. Leaves opposite, needle-like; cones small, fleshy or woody.
        E. Leaves with whitish marks above; cones fleshy. — *Juniperus*
        EE. Leaves with whitish marks beneath; cones woody. — *Chamaecyparis*
      DD. Leaves linear, awl-shaped, spirally arranged; cones larger woody.
        E. Leaves strongly keeled. — *Cryptomeria*
        EE. Leaves not or only slightly keeled. — *Sequoiadendron*
    CC. Leaves linear, more or less flattened or sometimes angular.

D. Leaves and lateral branches deciduous; leaves light green and soft. (Fig. 20).
E. Leaves and lateral branches alternate. *Taxodium*
EE. Leaves and lateral branches opposite. *Metasequoia*
DD. Leaves evergreen, bright to dark green.
E. Leaves decurrent; branches without conspicuous leaf-scars.
F. Leaves radially spreading, very stiff-spiny pointed, green on both surfaces. *Araucaria**
FF. Leaves spreading in 2 ranks, with 2 whitish bands beneath.
G. Leaves distinctly and rigidly spiny pointed.
H. Leaves bright green, gradually narrowed into a long stiff spiny point, with a broad base and with 2 broad whitish bands beneath. (Fig. 22). *Cunninghamia*
HH. Leaves dark green, abruptly narrowed into a very short spiny point, with a narrow base and with 2 narrow whitish or brownish bands beneath.
I. Leaf-points sharp to touch. (Fig. 21B). *Torreya*
II. Leaf-points not sharp to touch. *Podocarpus* in part*
GG. Leaves shortly pointed, not spiny, the tips blunt.
H. Branchlets opposite; leaves 2-8 cm. or more long, abruptly narrowed into a short petiole; terminal buds usually 3. (Fig. 21C). *Cephalotaxus*
HH. Branchlets alternate; leaves short, 2.5 cm. or less long, narrowing gradually to the base; terminal bud solitary.
I. Leaves with 2 pale green to tawny-yellow broad bands beneath; bud-scales rounded. (Fig. 21A). *Taxus*
II. Leaves with 2 whitish broad bands beneath; bud scales acute.
J. Leaves distinctly 2-ranked; main branches not whorled.
K. Leaves dimorphic, those of lateral shoots linear, those of long shoots scale-like; tall trees. *Sequoia**
KK. Leaves all alike, without scale-like ones; low trees or shrubs. *Podocarpus* in part*
JJ. Leaves indistinctly 2-ranked, slightly twisted; main branches whorled. *Saxegothaea**
EE. Leaves not decurrent; branches with conspicuous smooth or raised leaf-scars. (Fig. 23).
F. Branches roughened by persistent distinctly raised leaf-scars.
G. Leaves with a short petiole and with whitish bands beneath or on both surfaces; main branches usually not whorled. *Tsuga*
GG. Leaves sessile, with whitish bands above; main branches usually whorled. *Picea*
FF. Branches smooth or nearly smooth, not roughened by leaf-scars.
G. Leaf-scars disc-like, circular, not colored; leaves more or less stiff; buds roundish to oblong, blunt or pointed.
H. Leaves flattened, keeled above, pale green below; buds roundish. *Keteleeria**
HH. Leaves flattened, grooved above, sometimes 4-angled, usually with whitish bands beneath; buds oblong. *Abies*
GG. Leaf-scars oval, colored; leaves soft to the touch; buds spindle-shaped, sharp-pointed. *Pseudotsuga*
AA. Leaves (mature adult ones) small and scale-like, opposite, more or less appressed to the stem. (Fig. 24).
B. Branch systems in flattened sprays, frond-like.
C. Branch systems spreading in horizontal planes or arising at different planes, usually paler green beneath.
D. Leaves of alternate pairs of more or less equal length and size.
E. Leaves smaller, 1.5-3 mm. long; cones rounded, the scale 4-sided, with a distinct boss in the center of each. *Chamaecyparis* in part
EE. Leaves larger, 2.5-6 mm. long; cones conical, the scale thin, pointed.
F. Branchlets slender, to 4 mm. broad; leaves with or without white markings beneath, the lateral leaves appressed to the stem. *Thuja*
FF. Branchlets much flattened, 5-6 mm. broad; leaves with conspicuous white batches beneath, the lateral ones somewhat spreading. *Thujopsis*
DD. Leaves of alternate pairs of very unequal size, the lateral ones much larger than and nearly covering the facial ones.
E. Leaves narrow, oblong, sharp-pointed, 2-3 times as long as broad, bright green on both surfaces. *Heyderia (Libocedrus)*
EE. Leaves ovate, blunt to slight pointed, less than 2 times as long as broad, whitish beneath. *Chamaecyparis* in part
CC. Branch systems spreading in vertical planes, green on both sides. *Biota*
BB. Branch systems not in flattened sprays.
C. Leaves all scale-like; cones woody. *Cupressus* in part*
CC. Both scale-like and needle-like leaves often present on the same plant; cones fleshy, berry-like. *Juniperus* in part

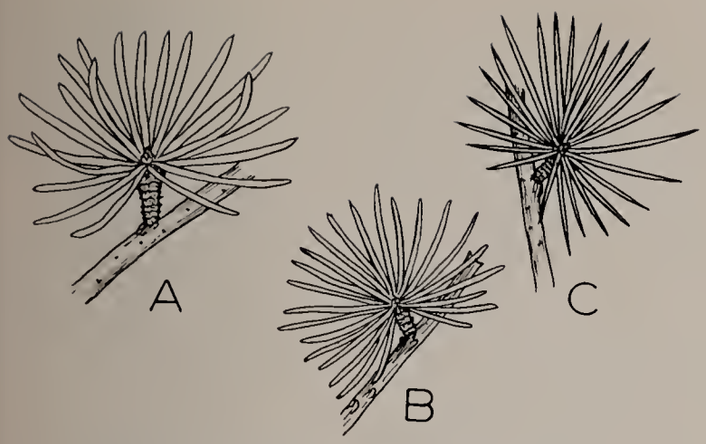



Fig. 19. Foliage of (A) *Pseudolarix amabilis*, (B) *Larix decidua*, and (C) *Cedrus libani*. × ½

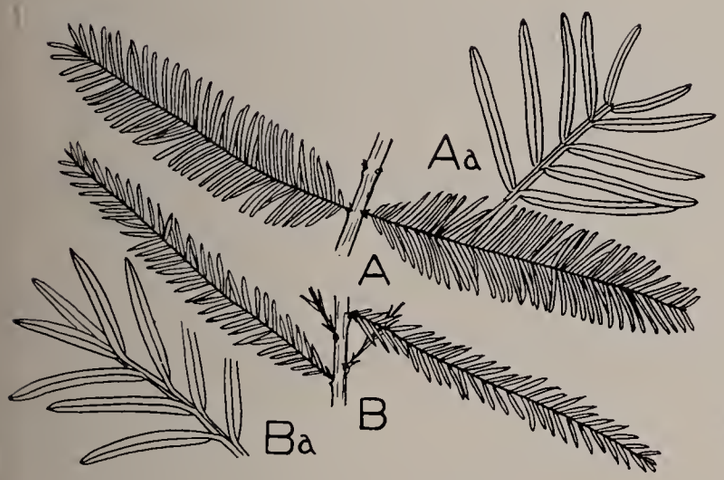



Fig. 20. Foliage of (A) *Metasequoia glyptostroboides* and (B) *Taxodium distichum*. A & B × ½. Aa & Ba × 1½

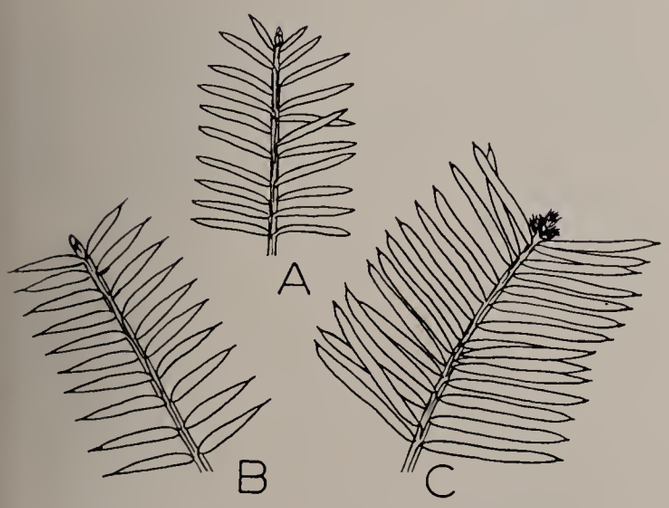



Fig. 21. Foliage of (A) *Taxus baccata*, (B) *Torreya nucifera*, and (C) *Cephalotaxus drupacea*. × ½



Fig. 22. *Cunninghamia lanceolata*. × ½

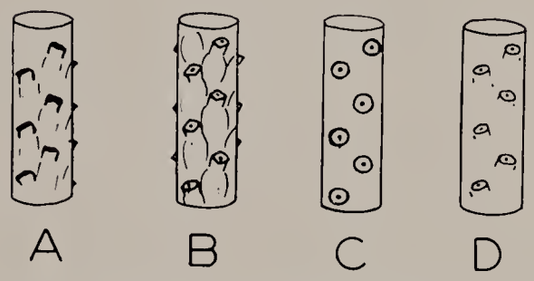



Fig. 23. Diagrams showing leaf-scars of (A) *Tsuga*, (B) *Picea*, (C) *Abies*, and (D) *Pseudotsuga*.

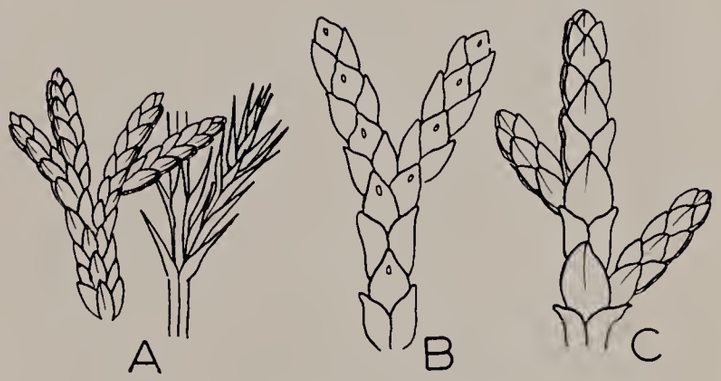






Fig. 24. Foliage of (A) *Juniperus virginiana*, (E) *Chamaecyparis Lawsoniana*, (C) *Cupressus macrocarpa*, (D) *Thuja occidentalis*, (E) *Biota orientalis*, (F) *Thujopsis dolobrata*, and (G) *Heyderia decurrens*. × 3

1. ABIES Fir (Fig. 23C)
There are about 40 species widely distributed in the mountains and the cooler parts of the Northern Hemisphere. Many of these are in cultivation. Most of them grow best in a cool and humid climate. Some of the western North American species like Colorado Fir, *A. concolor* and Noble Fir, *A. nobilis,* and Asiatic species like Nikko Fir, *A. homolepis* of Japan and Farges Fir, *A. Fargesii* of China, do very well in the eastern states, while other species from Asia and Europe do not prove satisfactory.

2. ARAUCARIA Southern Pine
There are about 20 species, all of the Southern Hemisphere and the tropics. The Monkey-Puzzle, *A. araucana* of Chile, is the hardiest species, and can be grown in the open as far north as southern New Jersey.

3. BIOTA Oriental Arbor Vitae (Fig. 24E)
The only species, *B. orientalis* from eastern Asia, is sometimes included in the genus *Thuja.* Numerous forms of this tree with different habit occur in cultivation and can be adapted for various purposes in landscaping.

4. CEDRUS Cedar (Fig. 19C)
The true Cedars are among the most valuable ornamental trees. Three of the 4 species are in cultivation: Atlas Cedar, *C. atlantica* of North Africa, Cedar of Lebanon, *C. libani* of western Asia, and Deodar Cedar, *C. deodara* of the Himalayas. The latter is not always hardy in the Philadelphia region.

5. CEPHALOTAXUS Plum-Yew (Fig. 21C)
This is a small genus of Eastern Asia, with 2 of its 8 or 9 species more or less common in cultivation, namely, Japanese Plum-Yew, *C. drupacea* and Chinese Plum-Yew, *C. Fortuni.* These plants resemble the Yews but are more graceful in appearance because of their longer foliage.

6. CHAMAECYPARIS Cypress (Fig. 24B)
The genus with its 6 species is confined to Formosa and Japan in eastern Asia and the Pacific and Atlantic coasts in North America. The eastern American *C. thyoides,* White Cedar, is the smallest and the least attractive. The western American *C. nootkatensis,* Nootka Cypress, and *C. Lawsoniana,* Lawson Cypress, do not do so well in the eastern United States as the two Japanese species, *C. obtusa,* Hinoki Cypress, and *C. pisifera,* Sawara Cypress. These two latter species include many horticultural forms.

7. CRYPTOMERIA Cryptomeria
There is a single species in China and Japan, extensively cultivated, especially in the latter country, as a forest and ornamental tree. It is frequently planted, particularly the form 'Lobbii,' in the Philadelphia region, doing well in certain locations but subject to much winter browning in others.

8. CUNNINGHAMIA Chinese Fir (Fig. 22)
There are 2 species in China, one, *C. lanceolata,* is the most important timber tree there. A distinctive looking tree with its bright green long spiny leaves, it is hardy in the Philadelphia area but does not do so well as in regions farther south.

9. CUPRESSUS Cypress (Fig. 24C)
There are some 12 species in North Africa, Asia and western North America. Most of these species are tender and can be planted only in mild climates.

10. FITZROYA Fitzroya
There is a single species, *F. cupressoides,* a tree in southern Chile, its native habitat, but it often becomes shrubby in cultivation. The tree is not hardy in the open in Philadelphia.

11. HEYDERIA Incense Cedar (Fig. 24G)
The 3 species of Incense Cedars of the Northern Hemisphere were formerly included in *Libocedrus,* a genus now considered distinct and exclusively of the Southern Hemisphere. The California species, *H. decurrens,* with a very distinct columnar habit, is hardy in the Philadelphia region but is of very slow growth.

12. JUNIPERUS Juniper (Fig. 24A)
There are some 60 species widely distributed in the Northern Hemisphere; about half of these are now in cultivation. The different species of this genus adapt to a wide variety of soil and climate conditions. The most commonly planted species are Common Juniper, *J. communis,* Chinese Juniper, *J. chinensis,* and Red Cedar, *J. virginiana,* each running into numerous garden forms.

13. KETELEERIA Keteleeria
There are about 4 species in southern China, trees resembling closely Firs in general appearance, but adapt more to warmer and dryer conditions. *K. Davidiana* is the most commonly planted species and probably the hardiest, but it can not be grown as far north as Philadelphia.

14. LARIX Larch (Fig. 19B)
There are about 11 species in the mountains and northern parts of the Northern Hemisphere, most of them in cultivation. The Larches are tall deciduous trees. Among the most commonly cultivated species are European Larch, *L. decidua* and American Larch, *L. laricina.* The Japanese Larch, *L. leptolepis* and Dahurian Larch, *L. Gmelini,* are also frequently planted and have proven satisfactory.

15. METASEQUOIA Metasequoia (20A)
There is a single species, *M. glyptostroboides,* a relatively recent discovery from central China. The tree is deciduous, resembling the Bald Cypress in foliage, but with opposite instead of alternate branchlets and leaves. It has proven to be not only a highly ornamental tree but also a rapid grower, hardy to cold climates and free of diseases.[1]

16. PICEA Spruce (23B)
There are about 30 species widely distributed in the colder parts of the Northern Hemisphere. A large number of the species are in cultivation. Among the most widely used species are Norway Spruce, *P. Abies,* White Spruce, *P. glauca,* and Blue Spruce, *P. pungens.* On the whole, the European species are doing better in the eastern states than species from Asia.

17. PINUS Pine
The Pines are among the best known and most widely planted trees. There are about 80 species widely distributed throughout the Northern Hemisphere. At least half of that number are in cultivation. Especially outstanding among the exotic ornamental species are Himalayan Pine, *P. Griffithii,* valued for its long graceful foliage, Lace Bark Pine, *P. Bungeana,* for its chalky white bark, and Japanese White Pine, *P. parviflora,* for its reddish bark and its picturesque form (assumed usually through grafting).

18. PODOCARPUS Podocarpus
There are about 70 species widely distributed in the Southern Hemisphere and the tropics. Only a few species, mostly from eastern Asia, are cultivated in subtropical or warm temperate regions or in the greenhouse in the north.

19. PSEUDOLARIX Golden Larch (Fig. 19A)
There is a single species, *P. amabilis* from eastern China, a deciduous tree resembling closely the Larches. This handsome tree has a well balanced, broad-pyramidal shape and feathery bright green foliage. The tree is slow in growth and does not like limy soil.

20. PSEUDOTSUGA Pseudotsuga (Fig. 23D)
There are 6 species in the genus, 4 in eastern Asia and 2 in Pacific North America. The Asiatic species are more or less rare plants and are also rare in cultivation. The American species, *P. taxifolia,* Douglas Fir, a variable plant, is most widely planted.

21. SAXEGOTHAEA Prince Albert Yew
There is a single species in southern Chile, *S. conspicua,* a small tree occasionally planted in warm regions.

22. SCIADOPITYS Umbrella Pine
There is a single species, *S. verticillata,* peculiar to Japan, a celebrated ornamental tree. It is slow growing in cultivation and it grows best in retentive moist soil. The tree, with its exceptionally long and broad needles and dense pyramidal habit, is very distinct in its appearance.

23. SEQUOIA Redwood
The only species, *S. sempervirens,* the well known Redwood of California, is a lover of moisture and a characteristic tree of the coastal fog belt in northern California. Unfortunately this famous tree is not hardy in the Morris Arboretum although it can be grown in more southern areas.

24. SEQUOIADENDRON Big Tree
The only species, *S. giganteum,* is the largest of all trees. Its original range in California is restricted to a narrow belt along the western slope of the Sierra Nevada. In cultivation this tree barely survives in the Philadelphia region and is very slow in its growth here.

25. TAXODIUM Deciduous Cypress (20B)
There are 3 species, 2 in southeastern United States and 1 in Mexico. The 2 northern species are semi-aquatic trees growing in or near water or in low swamps. Both the Bald Cypress, *T. distichum,* and Pond Cypress, *T. ascendens,* grow well in the Philadelphia area, in swampy as well as upland locations. The latter is sometimes mistaken for *Glyptostrobus,* an Asiatic genus which is not hardy here.

26. TAXUS Yew (Fig. 21A)
There are about 7 species widely distributed in Europe, Asia and North America, sometimes treated as varieties or races of one species as they very closely resemble each other and are often difficult to distinguish. The most widely planted species are English Yew, *T. baccata* and Japanese Yew, *T. cuspidata,* each running into many garden forms.

27. THUJA Arbor Vitae (Fig. 24D)
There are 5 species in Asia and North America. All species are of mountainous habitat and prefer shady moist situations. Numerous horticultural forms occur in the American Arbor Vitae, *T. occidentalis,* the most widely cultivated species.

28. THUJOPSIS Hiba Arbor Vitae (Fig. 24F)
The single species, *T. dolobrata,* originally from Japan, is a handsome ornamental tree resembling somewhat the Arbor Vitae in appearance but with larger foliage. It is possibly barely hardy in the Philadelphia region but it does not seem to be in actual cultivation here.

[1] See Morris Arboretum Bulletin, Vol. 4, p. 94. 1949.

29. TORREYA Torreya (Fig. 21B)

There are 6 species in discontinuous areas in warm temperate and subtropical Asia and North America. Two species occur in North America, one in Florida and the other in California. Most of the species, small handsome trees, are in cultivation while the most commonly planted one is Japanese Torreya, *T. nucifera* from Japan.

30. TSUGA Hemlock (Fig. 23A)

There are about 10 species, of the mountainous regions of eastern Asia and North America. The species thrive best along banks of rivers. In the eastern United States, besides the native *T. canadensis,* Common Hemlock, other species like Japanese Hemlock, *T. diversifolia* and Chinese Hemlock, *T. chinensis* and others also do well but the Pacific coastal species like Western Hemlock, *T. heterophylla* and others do not prove to be satisfactory.

# Cultivated Spruces in the Philadelphia Area

JONATHAN W. WRIGHT[1]

The genus *Picea* (spruce) is one of the largest and most useful of the conifer genera. It contains about 31 species, nearly all of which grow on mountains or in northern latitudes. The spruces are useful horticulturally because of their dense foliage, regular crowns, and comparative freedom from pests. For these reasons they are favorites for landscape planting wherever large, erect evergreens are desired. Also, they are becoming favorites among Christmas tree growers and buyers. Spruce is also important to the wood-using industries of the northern United States, Canada, northern Europe, and northern Asia. In these regions there are millions of acres of spruce forests that yield a high grade of sulfite pulp valuable for the manufacture of newsprint and rayon.

Spruce needles are short (¼ to 1½ inches); they are sharp pointed; they are borne singly; and they are all of the same length on a given twig. The twigs are lined. The cones are pendant, medium-sized, have thin scales, and are usually borne only in the top of the crown. One or more of these characteristics may be used to distinguish spruce from pine (long needles borne in groups of 2 to 5, thick-scaled cones), fir (blunt needles, erect cones), hemlock (blunt needles of varying lengths, small cones borne over the entire crown), cedar (needles in clusters, erect cones), and other common conifers.

Distinguishing one spruce from another is a more difficult task. For one thing, all the spruces lose their needles soon after being cut; and herbarium specimens quickly become just naked twigs and loose needles. This makes it difficult to compare fresh material with standard named specimens. For another thing, there are few species that have a single characteristic that is distinctive enough for positive identification. Among such species are Norway spruce (long cones), oriental spruce (very short, blunt needles), tigertail spruce (very thick, sharp needles), Himalayan spruce (long needles), and Serbian spruce (flat, soft needles). In other cases a combination of several different characteristics must be considered.

Although most of the spruces have been known for 50 years or more, and were introduced into the Philadelphia area more than 30 years ago, only three species are commonly met with outside of arboreta and large estates. Thus most of the growth observations recorded in this paper were made on a few arboretum trees, supplemented whenever possible by observations on trees in private yards or in forest plantings. No attempt was made to cover the entire Northeast, but a few pertinent observations on trees outside the Philadelphia area (particularly in Highland and Durand Eastman Parks, Rochester, N. Y.) have been included.

In a brief paper such as this, it is impossible to do more than mention the highlights of the most important species. Therefore, table 1 was prepared to give some growth information about all spruce species, including those not mentioned in the text.

[1] The author is Geneticist, Northeastern Forest Experiment Station, U. S. Forest Service, Upper Darby, Pa. He is stationed at the Morris Arboretum, where many of the observations recorded in this paper were made.

Table 1. *Maximum sizes and growth rates of planted open-grown spruces on the grounds of the Morris Arboretum, Westtown School, and Haverford College, all near Philadelphia*[1].

| Common name | Scientific name, *Picea*— | Age[2] | Total height | Height growth per year | Diameter breast high |
|---|---|---|---|---|---|
| | | *Years* | *Feet* | *Feet* | *Inches* |
| | AMERICAN SPRUCES | | | | |
| White | *glauca* (Moench) Voss | 30 | 43 | 1.4 | 14 |
| Blue | *pungens* Engelm. | 47 | 34 | 1.4 | 10 |
| Red | *rubens* Sarg. | 8 | 10 | 1.2 | 2 |
| Black | *mariana* (Mill.) B. S. P. | 47 | 29 | .6 | 8 |
| Engelmann | *Engelmannii* Parry | 29 | 35 | 1.2 | 10 |
| Sitka | *sitchensis* (Bong.) Carr. | 17 | 8 | .5 | 1 |
| Brewer | *Breweriana* S. Wats. | 18 | 3 | .2 | — |
| | EUROPEAN SPRUCES | | | | |
| Norway | *Abies* (L.) Karst | 33 | 65 | 2.1 | 18 |
| Oriental | *orientalis* (L.) Link. | 50 | 75 | 1.5 | 16 |
| Serbian | *omorika* (Pancic) Purkyne | 30 | 50 | 1.7 | 10 |
| | JAPANESE SPRUCES | | | | |
| ——— | *Maximowiczii* Reg. | 37 | 48[3] | 1.7 | 14 |
| Tigertail | *polita* (Sieb. and Zucc.) Carr | 45 | 45 | 1.0 | 13 |
| Koyamai | *Koyamai* Shirasawa | 25 | 32 | 1.3 | 11 |
| Alcock | *bicolor* (Maxim.) Mayo | 27 | 23 | .8 | 10 |
| Sakhalin | *Glehnii* (Fr. Schmidt) Masters | 17 | 17 | 1.0 | 7 |
| Yeddo | *jezoensis* (Sieb. and Zucc.) Carr. | 15 | 14 | .9 | 4 |
| | CHINESE SPRUCES | | | | |
| ——— | *asperata* Masters | 40 | 46 | 1.2 | 12 |
| ——— | *retroflexa* Masters | 28 | 15 | .5 | 4 |
| ——— | *Balfouriana* Rehd. and Wilson | 28 | 18 | .6 | 6 |
| ——— | *montigena* Masters | 28 | 20 | .7 | 8 |
| ——— | *Wilsonii* Masters | 17 | 17 | 1.0 | 5 |
| ——— | *purpurea* Masters | 17 | 15 | .9 | 3 |
| ——— | *brachytyla* Masters | 16 | 6 | .4 | 1 |
| | OTHER ASIATIC SPRUCES | | | | |
| Himalayan | *Smithiana* Boiss. | 18 | 8 | .4 | 1 |
| ——— | *Schrenkiana* Fisch. and Meyer | 30[4] | 21 | .7 | 8 |
| Siberian | *obovata* Ledeb. | 14 | 16 | 1.1 | 4 |

[1] Data are included on all species except the Mexican *P. chihuahuana* Martinez, the Himalayan *P. spinulosa* (Griff.) Henry, and the Formosan *P. morrisonicola* Hayata, of which the author has seen no specimens.

[2] The ages refer to the period since the tree was 1 foot tall.

[3] A large portion of the crown broke off several years ago.

[4] This specimen is located in Durand Eastman Park, Rochester, N. Y. The species is not represented in the Philadelphia area.

## The American Spruces

White spruce *(Picea glauca* (Moench) Voss) has the largest natural range of any American species. Extensive forests are found in New England and eastern Canada, and across Canada and Alaska almost to the Pacific Ocean. Since this is so, it is peculiar that its large-scale use for ornamental and forest planting is a recent phenomenon. Planted trees more than 30 years old are a rarity, but there are thousands less than 20 years old.

White spruce often has almost as blue foliage as the blue spruce. In Philadelphia it is faster growing in youth than the latter species, and for that reason is frequently used by new homeowners who need sizable trees at a reasonable price. The foliage color and sturdy branches have also brought this species into use as a Christmas tree in recent years. Some buyers object to the "cat" odor of the fresh needles, but this is largely dissipated if the trees are cut and stored outside for a few days before being brought into a warm room.

In late summer white spruce drops its needles of the previous year. The browning needles make the trees appear sickly for a period of 2 or 3 weeks. This is a regular annual occurrence, and it need not cause concern.

The blue spruce *(Picea pungens* Engelm.) Fig. 25, is a native of high altitudes in the southern Rocky Mountains. It grows slowly in youth and therefore is a fairly expensive tree to buy. People rarely plant it in large numbers, yet there is hardly a village in the Northeast which does not have at least one or two nice specimens up to 50 feet tall. It grows well in Philadelphia, and even better in the cooler parts of the Northeast.

The foliage of this species is not always blue. In an ordinary seedling population one may find blue, blue-green, or almost green trees. Some nurserymen grow only blue trees (usually of the Koster variety) by propagating with grafts or cuttings. Others grow seedlings and discard the greenest ones.

Red spruce *(Picea rubens* Sarg.) has been planted sparingly outside of arboreta even though it is native within 100 miles of Philadelphia. One probable reason for this is the difficulty of growing it in a nursery. One New York nurseryman who grows most species by the millions was able to grow only about 5,000 plantable trees in the best of four tries, even though the nursery is only a few miles from native stands. The planted trees look and grow about the same as wild trees. They are short-needled, dark green, dense-crowned, and of moderately fast growth.

Engelmann spruce *(Picea Engelmannii* Parry) is another species from the Rocky Mountains that appears promising in the Philadelphia area. It is often as blue and as fast-growing as blue spruce but has a more ragged crown.



Figure 25. Blue spruce has been planted in almost every part of the northeast.

## The European Spruces

The three European species—Norway, Serbian, and Oriental spruce — were introduced into the Philadelphia area earlier than any other species except blue spruce. Therefore the trees have reached larger sizes than other species. All three thrive here, growing as fast as they do in their native lands, and as fast as or faster than the American spruces.

Norway spruce *(Picea Abies* (L.) Karst) is the second most important tree species of Europe. (Fig. 26.) It is the backbone of the Scandinavian pulp and paper industry and it provides lumber throughout northern Europe. It got its big start here in 1876 when an enterprising nurseryman offered potted seedlings for sale at the Centennial Exposition in Philadelphia. They sold well, and many of those seedlings, now 80-year-old veterans, are still living in Pennsylvania and New Jersey farmyards. The species has been used as an ornamental ever since, and trees of almost all ages are to be found throughout the Northeast. Large-scale forest planting started in the early 1900's in the Adirondack Mountains of New York. Many of those early plantations are now producing lumber and pulpwood. They provided the stimulus for planting thousands of acres during the last three decades.

Like the other spruces, Norway spruce sheds its needles quickly if cut and allowed to dry out. However, cut trees retain their needles very well if

left standing in water. As people have discovered this, many—including myself—have come to prefer the dense, full-crowned Norway spruce for their Christmas trees.

The large cones of Norway spruce furnish seeds for the next crop of trees. They also serve as models for many Christmas card and clock designers. The winding weights of traditional German cuckoo clocks are usually reproductions of *Fichtenzapfen* (spruce cones).

In young Norway spruce up to 25 or 30 feet tall the branches are horizontal or ascend slightly. Some trees retain this branching habit throughout life. In others the large branches bend downward and the large twigs near the ends of the branches may hang almost vertically as the trees grow older. Such older trees have a gracefully drooping appearance unmatched in other evergreens.

Oriental spruce *(Picea orientalis* (L.) Link.) is a native of the Caucasus Mountains of Asia Minor, where it grows at elevations of 3,000 to 7,000 feet in mixture with fir and pine. (See Cover.) In its homeland it grows to a maximum height of 180 feet. The largest trees in the Philadelphia area are now only about 75 feet tall, but they are still vigorous, and give reason for us to believe that we may expect giants here as well as in Asia Minor. This species also grows well near Poughkeepsie, N. Y., and in Rochester, N. Y.



Figure 26. Norway spruce is the fastest growing of the spruces.



Figure 27. The dense foliage and gracefully curving branches are characteristic of Serbian spruce.

There are several 50- to 60-year-old oriental spruces in the Philadelphia area, but younger trees are rare. Probably only one or two nurserymen ever distributed the species. This is difficult to imagine, for the tree is handsome, with its dense dark green foliage and narrow, regular crown. Perhaps, as with the red spruce, the difficulty of growing nursery stock is the reason. We recently tried to grow several thousand seedlings for a forestry planting. The seed germinated well but the seedlings died off from various causes until only a few were left at the end of 3 years.

The Serbian spruce *(Picea omorika* (Pancic) Purkyne) is my favorite. (Fig. 27.) It has very fine branches that sweep downward and upward gracefully, even in young trees. The upper surface of the flat needles is dark green, and the lower surface is whitish. On a windy day this contrast in needle color gives the tree a two-toned effect. The trees start to cone early—often when only 8 or 10 feet tall—and retain their cones for years after they ripen.

The present natural range of the Serbian spruce is limited to a very small area about 20 miles long in the Drina River basin of Yugoslavia, although in prehistoric times it seems to have ranged as far north as Czechoslovakia. This already small natural range seems to be decreasing. One might expect

such a delicate species to be a total failure when planted outside its native habitat; but it thrives in Philadelphia, Rochester, and several places in northern Europe. It is even fairly easy to grow in the nursery, and should become a standard nursery item as people become better acquainted with its graceful form.

### The Japanese Spruces

Six species of spruce are found in the mountains of Japan or Sakhalin. They are dissimilar botanically and genetically but all of them grow moderately well to very well in Philadelphia.

*Picea Maximowiczii* Reg. is the fastest growing of the Japanese species. (Fig. 28.) It has thin, sharp needles and a regular, light-green crown. Although planted only in arboreta, it deserves attention from homeowners and foresters. The trees grow almost as fast as Norway spruce. This species shares with the Sitka spruce the interesting habit of "feathering" or developing new branches on the lower trunk of open grown specimens if the lower branches are cut.

The tigertail spruce thoroughly deserves its common name but not its scientific name—*Picea polita* (Sieb. and Zucc.) Carr. Its stout needles are extremely sharp, making a twig of blue spruce seem almost like a featherbed by comparison. It is thrifty but slow-growing in plantings in Philadelphia and Rochester, and will probably be planted only as a curiosity.



Figure 28. Maximowicz spruce is a fast growing Japanese species which merits attention from foresters and horticulturists.



Figure 29. Koyamai spruce was known for years from only a single stand in Japan.

The Koyamai spruce *(Picea Koyamai* Shirasawa) was first described in 1913 from Japan, where it is an extremely rare tree occurring in two groves on one mountain. (Fig. 29.) Later it was described from Korea and Manchuria, where it is an important timber tree. In spite of its recent introduction into the Occident, it has already established a reputation as a potentially valuable timber and ornamental tree in places as far apart as Finland, Illinois and Pennsylvania. The Morton Arboretum near Chicago has a small, closely spaced forest planting which is growing about as fast as any spruce in the area although it suffered winter browning on one occasion. The four Philadelphia specimens (probably one pair is from Japan, and the other pair is from Korea) are fast-growing and hardy. They are similar in general appearance to the Norway spruce, but are slightly broader crowned and have a little grayer foliage.

The Alcock spruce is a very rare tree with us, even in arboreta. It derives its scientific name—*Picea bicolor* (Maxim.) Mayr — from the two-toned color of the foliage. The single specimen at the Morris Arboretum is thrifty and has a broad, irregular crown. In an older specimen on the Hunnewell estate near Boston the lower branches have layered, giving a ring of young trees around the original one.

The Sakhalin *(Picea Glehnii* (Fr. Schmidt) Masters and Yeddo *(Picea jezoensis* (Sieb. and Zucc.) Carr. spruces from northern Japan and Sakhalin (the latter species also occurs on Kamtchatka and the Siberian mainland), perhaps find our climate a little too warm. Both are very slow-growing in Philadelphia, but the former is growing as fast as our native American species in Rochester and in Montgomery County, New York. The Yeddo spruce would make a desirable tree for foundation plantings and groups of small evergreens because of its two-toned foliage and compact growth habit.

### Other Asiatic Spruces

The Chinese spruces are of more interest to botanists than to horticulturists and foresters. They occur naturally in the rugged mountains of western China, far from the normal tourist routes, and are known to western botanists only through the writings of plant explorers such as Masters, Wilson, Hu, and Teng, and through a few arboretum and herbarium specimens. On the whole they have shown less growth promise than most of the European and Japanese species.

*Picea asperata* Masters, which comes from a part of China that has a climate similar to that of Philadelphia, grows the fastest of the planted Chinese spruces. It is similar in general appearance to Norway spruce, but is broader crowned and has thinner, grayer foliage. Some of the varieties that have been tested near Philadelphia are more shrublike and have denser, bluer foliage than the typical species.

One of the Chinese spruces, *Picea montigena* Masters, has blue needles similar to those of blue spruce. The two Philadelphia specimens of this species are thrifty but slow-growing, and have very broad, irregular crowns. The female flowers are showy, even in comparison with some of the annuals commonly grown in gardens. They are almost 2 inches long, and are a brilliant crimson. Unfortunately they are not seen by many people since they are hidden in the tops of the trees and are showy for only a few days.

### Where To Obtain Spruce Seed and Seedlings

Three spruces — Norway, white, and blue — are commonly available in commercial nurseries that handle ornamental stock. The first two are also available from most state forest tree nurseries. Most of the other species have been stocked only rarely and for short intervals by nurseries that specialize in rare plants.

Seed of Norway, white, blue, Engelmann, sitka *(Picea sitchensis* (Bong.) Carr.) and red spruce is commonly available from commercial houses handling tree seed. Good quality crossed seed of Oriental and Serbian spruce can be collected from occasional planted groups of two or more trees of these species, and is sometimes available commercially. Seed of the lower-altitude Japanese species *(P. polita, P. bicolor, P. Glehnii,* and *P. jezoensis)* may be obtained without great trouble by arrangement with local collectors. Native-grown seed of most other species is difficult to obtain because of the inaccessibility of the forest stands.

It usually does not pay to collect seed from planted trees of any but the commonest species. In isolated trees there is no opportunity for adequate cross-pollination; and the seed is usually empty, selfed, or hybrid. Neither the selfed nor the hybrid seed gives trees like their parents.

Spruce seedlings grow very slowly at first, requiring regular watering, weeding, and shading. The amateur is usually not well enough equipped to do these tasks at the right time. Therefore it is usually best to contract with a commercial nurseryman experienced in handling coniferous seedlings for the production of more than a few trees. If a few trees are desired, they may be propagated by grafting. This is especially recommended for species of which good seed is difficult to obtain.

## ARBORETUM ACTIVITIES

*(Continued from page 46)*

senting 41 species of oaks from 33 states and 7 foreign countries.

The acorns which were sent in during the autumn of 1953 were planted in the rodent-proof seed beds described in Vol. 5, p. 54. In the spring of 1955 the seedlings, then approximately 18 months old, were transplanted to the Quercetum nursery. The time has now come to move these young trees to their permanent position in the Arboretum. The site which has seen selected is a broad strip which runs parallel to the extreme northwestern boundary, adjacent to the Widener estate, and then turns to extend southward along Stenton Avenue. Here during November nearly 250 three-year-old oaks were set out in accordance with a carefully determined planting plan.

In the allocation of these young oaks to their permanent positions the following principles have been adopted:

1. By planting the saplings 20 feet apart adequate space is provided for their future development as mature trees.

2. In order to facilitate comparative studies representatives of a given species are placed in the same section. Thus, specimens of White Oak from Massachusetts, Pennsylvania, New Jersey, Maryland, Virginia, North Carolina, Illinois, Arkansas and Texas will be found growing side by side. Another section will contain specimens of the Red Oak from various areas within its natural range of occurrence, and similarly with all the other species.

3. To compensate for possible differences in soil and to make possible statistical studies each seed lot is being replicated three times. For example, specimens of *Quercus alba* No. 009 (from Texas) will be planted in three different sections of the total strip and may be as much as 500 feet from each other.

4. Open spaces in the area allotted to each species are being left to be filled in by future outplantings. In the case of the White Oak, for instance, gaps are provided to accommodate examples of the seedlots acquired in 1954 which will be moved to their places in the autumn of 1957, and so on through succeeding years.

It is obvious that we have embarked upon a long-term experiment the full significance of which cannot be evaluated for many years.

## Planting Plans

One of our chief concerns during recent months has been the preparation of a comprehensive plan for the establishment of new plantings on the tract lying to the north of Northwestern Avenue. This area, which was called Bloomfield by the Morris family and served as their farm, comprises about 70 acres. Except for having served as the site of several of our nurseries as well as the Langstroth Bee Garden and a few scattered plantings, this tract has been largely undeveloped by the Arboretum. It is now our intention to embark upon the ambitious program of moving into this area a series of plantings which will utilize its full potentialities and add significantly to the educational value of the Arboretum.

The first task has been the laying out of a roadway to provide access to the area. Our plan calls for an entrance off Northwestern Avenue some 150 feet to the east of the present gateway. From this point we have staked out a road which, following the contours of the land, first swings eastward, then follows northward paralleling Stenton Avenue, later turns west along the northern boundary of the property and finally articulates with an existing road which leads through a fine double avenue of sugar maples. One section of the proposed road will traverse a section of the oak plantings mentioned in the preceding section of these notes. Thus, as these trees develop to maturity an attractive driveway through a mixed oak stand will be provided.

In the development of a planting plan for this 70-acre tract we have adopted the principle of bringing together in one place as many examples of a given family or genus as is feasible. This concentration will enable visitors who are interested in a particular group of plants to see a large representation in a single location. For example, a series of Viburnums has already been established on a slope to the east of the proposed roadway; other species will be added until the planting contains all forms worthy of display which are hardy in this area. Near the Viburnums will be located other genera of the Honeysuckle Family, such as *Lonicera, Abelia, Weigelia, Symphoricarpus, Sambucus, Kolkwitzia* and *Diervilla.*

A large area near the entrance has been selected for the Rose Family and here will be exhibited the flowering cherries, crabs, cotoneasters, spiraeas and a multitude of other groups. The vast and important Legume Family, which includes redbud, locust, honey locust, yellow wood, pagoda tree, and many more, will find a home to the west of the new roadway along Northwestern Avenue. Space has been blocked out for several other groups, such as the barberries, the elms, the maples, the ashes, etc., while additional ones will be allocated as our plans mature. Future issues of the Bulletin will contain detailed information concerning the realization of these plans.

## Recreation Area

Between the first of April and the end of October more than fifty groups scheduled outings at the Arboretum's Recreation Area. When this figure is compared with the thirty-eight such events held during the 1955 season it is apparent that this feature of the Arboretum's public service is increasing in popularity.

J. M. F., Jr.

# New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since September 1956:

Mrs. Carl H. Anderson
Dr. and Mrs. Russell A. Anthony
Mrs. James W. Banham
Miss June C. Berry
Mrs. Philip Bregy
Mrs. H. Herbert Breneman
Mr. and Mrs. E. M. Buckey
Mrs. J. Gibson McIlvain Bunting
Mrs. James Cheston, 4th
Dr. William Rex Crawford
Mrs. Robert Dale
Mrs. Lawrence Davidson
Mrs. Richard M. Decker
Mrs. William R. Dohan
Dr. T. McKean Downs
Mrs. Robert H. Dunn
Mr. David P. Earnshaw
Mrs. Xaver von Erdberg
Mrs. Charles A. Fife
Mrs. Edwin M. Finletter
Mrs. Merrill J. Fowle
Mrs. Richard L. Freeman
Mrs. John F. Gall
Mr. Wilbur B. Gantz
Mrs. Wm. Blake Gibson
Mrs. W. Charles Hogg
Mrs. Cooper Howell
Dr. Horace H. F. Jayne
Miss Anne Jelinek
Mrs. Wm. Linton Landreth
Mrs. Thomas W. Linn
Mr. Philip Atlee Livingston
Mr. Otto T. Mallery
Mrs. Stephen R. Manley, Sr.
Mrs. William S. McCurley, Jr.
Mr. and Mrs. Henry Mitchell
Dr. and Mrs. Harold Morris
Mrs. Josephine V. Mygatt
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# Publications by Members of the Staff

The following books by members of the Staff of the Morris Arboretum are available at reduced prices to Associates:

Wherry, E. T. *The Genus Phlox.* Morris Arboretum Monograph III. 174 pages. Illust. Philadelphia 1955. $4.00. Price to Associates, $3.00

Wherry, E. T. *Wild Flower Guide.* 202 pages. 106 plates. New York 1948. $3.50. Price to Associates, $3.00

Wherry, E. T. *Guide to Eastern Ferns.* 220 pages. Illust. Lancaster 1937. $2.00. Price to Associates, $1.50

Li, H. L. *Chinese Flower Arrangement.* 122 pages. 10 figs. 20 plates. Philadelphia 1956. $4.00. Price to Associates, $3.50

Fogg, J. M., Jr. *Weeds of Lawn and Garden.* 215 pages. 176 figs. Philadelphia 1945. $2.50. Price to Associates, $2.00

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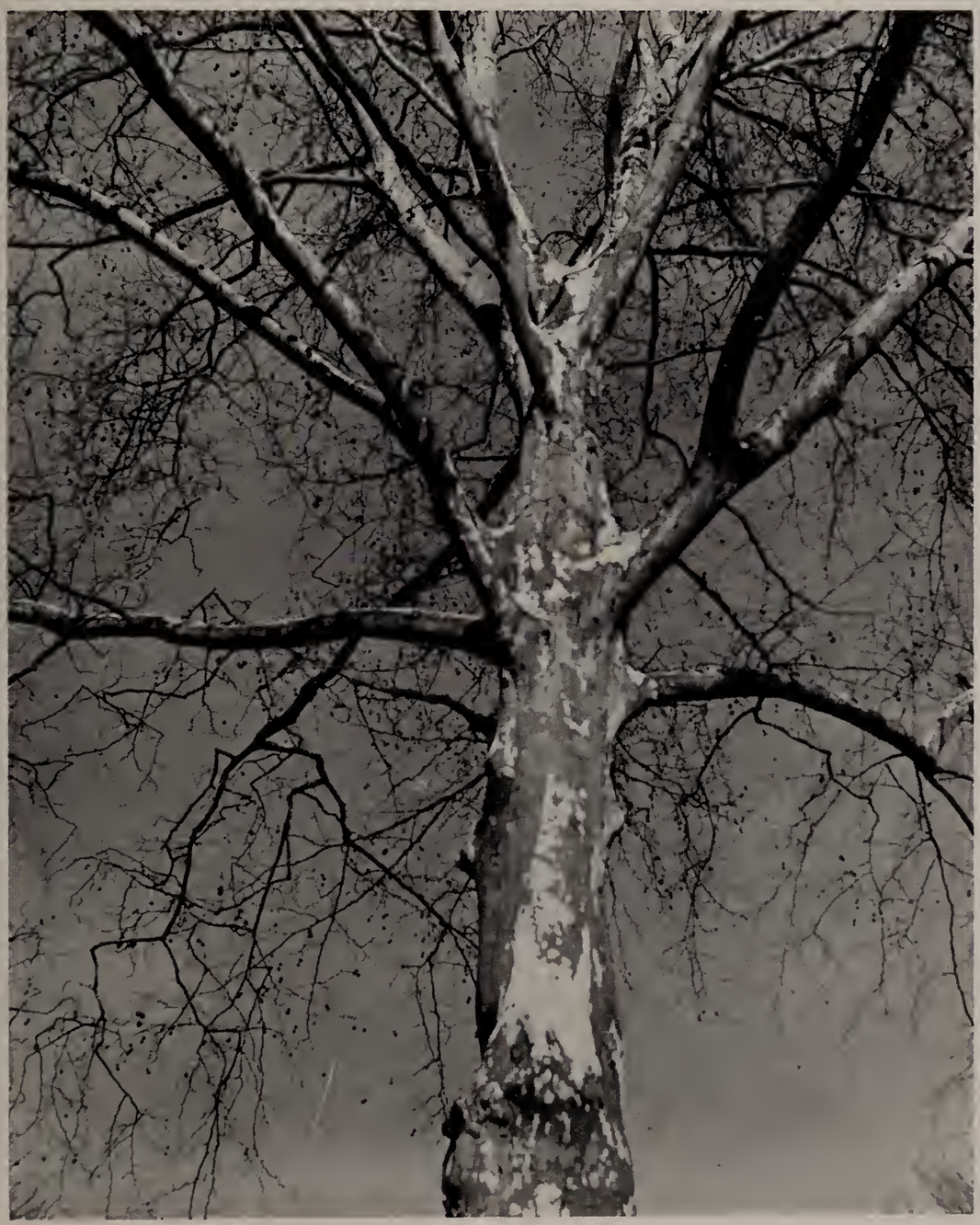
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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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# Arboretum Activities

Although the winter months constitute a period of dormancy for most growing things at the Arboretum they are by no means a time of forced inactivity for members of the staff. In fact, in many respects there is more concerted work accomplished here from November until March than may be the case during the growing season. This is due largely to the fact that many of our winter operations can be carried out regardless of the state of the weather, whereas inclement conditions during the summer months may interrupt all outdoor plans.

First of all, we must get ready for winter. This

*(Continued on page 18)*

# The Origin and History of the Cultivated Plane-trees

Hui-Lin Li

## Introduction

The familiar Plane-tree, the most widely planted street and shade tree in many American and European cities, is curiously, one of the most badly confused plants in horticulture. The three commonly planted species, the Oriental Plane, the American Plane and the London Plane, because of their generally similar and at the same time extremely variable foliage characters, are often wrongly identified, not only in trade catalogues but also in horticulture literature. The confusion is further aggravated by the uncertain origin of the London Plane, which has baffled horticulturists and botanists for many decades.

The London Plane is unknown in the wild state and apparently originated in cultivation. (See Cover and Fig. 1). In horticulture literature before the early years of the present century, it was generally considered as a variety of the Oriental Plane, and because of this, when the Oriental Plane or *Platanus orientalis* is mentioned in the literature, it may be referable either to the true Oriental Plane or to the London Plane, *P* × *acerifolia*. The prevalent consensus is that the latter is most probably a hybrid between the Oriental Plane and the American Plane, *P. occidentalis,* but the confusion does not abate. (Fig. 2).

Some of the confusion is probably due also to the many common and colloquial names applied to these trees; these names will be discussed below. For the present discussions, the common names used for the three species in question will be Oriental Plane for *P. orientalis,* American Plane for *P. occidentalis* and London Plane for *P.* × *acerifolia*. (Figs. 3, 4 and 5).

The Oriental Plane is one of the oldest and most cherished shade trees cultivated by men, and is still widely planted in many parts of the world. The American Plane came into cultivation during the 16th century, while the London Plane originated as a cultivated tree in about the later part of the 17th century. These three plants are among the most prominent features of the landscapes in many habitats of man's choice, from cities made of modern skyscrapers in America and Europe to towns made of mud huts among the steppes of western and central Asia. The story of the Plane-trees indeed is most instructive in illustrating vividly the mutual influences exerted by man and the surrounding vegetation on each other.

To trace the history of cultivation of the different Plane-trees, especially the mysterious and elusive origin of the London Plane, it is necessary first to take into account the genus *Platanus*, which, aside from the fact that it contains some of the most attractive and valuable shade trees, is a genus that will repay consideration.

## The Genus Platanus

The genus *Platanus* is the only member of the family Platanaceae, a family of special interest because of its isolated position and disputed relationships in the phylogeny of the flowering plants. The 8 or 9 species of *Platanus* are scattered in widely disjunct areas in the Northern Temperate Zone, a pattern of distribution which generally indicates antiquity. Actually the family history of *Platanus* is one of the most majestic, for paleobotanists trace its ancestry back to the



Fig. 1. *Platanus* × *acerifolia* at the Morris Arboretum.



Fig. 2. Leaves of *Platanus occidentalis* (left), *P.* × *acerifolia* (middle), and *P. orientalis* (right).

age of Dinosaurs in the late Cretaceous, some 100 million years ago.

The species of the genus *Platanus* more or less closely resemble each other in general appearance. They are tall deciduous trees with smooth bark shedding in broad, brittle, thin plates and exposing the whitish or brownish inner bark. The leaves are large, palmately lobed with toothed or smooth margins and with the leaf-stalks enlarged at base enclosing the winter buds. There are stipules usually sheathing the base of the leaf-stalks, of varying sizes and often falling off very early. The flowers are of distinct sexes produced on separate inflorescences on the same tree. They are very minute and simple, without perianth and closely packed in hanging globose heads. The fruiting heads remain attached to the tree during the winter on the otherwise bare branches, presenting a graceful appearance. These heads break up in late winter and the hairy fruits are widely distributed by winds. The wood of these trees, light brownish or reddish in color, splits poorly and is thus not highly valued.

There is one species in southeastern Europe and western Asia, *P. orientalis,* the Oriental Plane. In eastern North America, the American Plane, *P. occidentalis,* occupies a wide range from southern Maine to Ontario and Nebraska south to northern Florida and Texas. The variety *glabrata* occurs from central Iowa and Missouri to western Texas and northern Mexico.

In western North America *P. racemosa* occurs in southern California and Lower California, and *P. Wrightii* from New Mexico and Arizona to California and northern Mexico, sometimes planted in the latter region as a shade tree. Also known from Mexico are *P. mexicana* (also occasionally planted as a shade tree), and *P. lindeniana.* In addition, Standley proposes two species from Mexico, *P. chiapensis* and *P. oaxacana.* Thus seven species are recorded as occurring in Mexico, but some of them are local or only little known (Standley 1922). Inasmuch as the species are generally differentiated by leaf-shapes, and as these are extremely variable even on the same tree, it seems likely that as a result of critical monographic studies, fewer species will be recognized.

Paleobotanists have found that in the Tertiary many species of the genus were wide-spread through the northern part of the Northern Hemisphere, in all of Europe, northern Asia and North America north to the Arctic Circle (Seward 1931). Subsequently the Pleistocene glaciation exterminated the more northern populations and surviving species are now confined to the eastern Mediterranean region in the Old World and to eastern and western North America including Mexico. Inasmuch as a large num-



Fig. 3. *Platanus orientalis,* from planted tree, Morris Arboretum.



Fig. 4. *Platanus occidentalis,* from planted tree, Morris Arboretum.

ber of such Tertiary survivals are now found existing mostly in eastern North America and in China and Japan, the entire absence of *Platanus* from eastern Asia seemed to be very remarkable (Berry 1923).

However, in 1939, the French botanists Gagnepain (1939) made an interesting discovery: a plant was found in Loas, Indo-China, which had all the peculiar features of *Platanus* in the flowering structures but with un-lobed, entire-margined, and pinnate-veined ovate-lanceolate leaves. In spite of the striking difference in the vegetative structures, Gagnepain considered the plant as belonging properly to the genus *Platanus* and named it *P. Kerri.* (Fig. 6).

The Indo-Chinese species has a longer inflorescence than all the other species, with 9 to 11 heads in the fruiting clusters. In the other species, the fruiting heads vary from solitary as in the American *P. occidentalis* to 2 to 6 as in the Oriental *P. orientalis* and others. The larger number is considered as a more primitive character and in this sense the Indo-Chinese species probably represents the most primitive species of the genus in existence.

If this proves to be the case, as detailed studies of various other aspects of the plant will verify, the un-lobed entire-margined leaf may indicate a more basic type than the palmately lobed ones, long considered as distinctly characteristic of the genus. This discovery may thus prove of profound significance in the study of the fossil history of the flowering plants, as the genus *Platanus* has long been recognized as one of the most important and abundant of the earlier fossils of the flowering plants. Actually since fossil plants are usually identified by the shape and venation of detached leaves only, such identifications, as is well known among paleobotanists themselves, are frequently not quite reliable. The leaves of this Indo-Chinese species, if discovered in rock strata as fossil imprints, will never be recognized as belonging or even related to *Platanus.* This species, which apparently has not yet been noted by many paleobotanists, indicates that a revision in our interpretation of fossils pertaining to *Platanus* is to be expected.



Fig. 5. *Platanus* × *acerifolia,* from planted tree, Verree Road.

## The Oriental Plane

As noted above, the Oriental Plane occurs in southeastern Europe and western Asia, eastward to Kashmir, but the range has apparently been extended through long years of cultivation. Henry (1908) believes that it occurs wild in Albania, Greece, Cyprus. Crete, Rhodes, and Asia Minor, while the occurrence in the wild state elsewhere, such as Iran, Afghanistan, Kashmir, etc., is very doubtful. The wild form he considers to differ slightly from the cultivated form in the slightly smaller leaves with cuneate instead of truncate or cordate leaf-base, but as the range of variation in the shape of the leaves in both the wild and cultivated form is considerable, it is not easy to distinguish the two morphologically. The trees cultivated in England or elsewhere are derived from trees indigenous to Greece and Asia Minor. The leaves of the trees cultivated in Kashmir and Iran are much larger, with broad oblong-triangular segments, and according to Henry, perhaps represent a distinct race.

Since very ancient times, the Oriental Plane has been valued as an ornamental shade tree. Its shelter-giving qualities, the wide-spreading branches and large dense foliage, render it one of the most prized trees in the hot lands of the Near East. With its massive size and great age, it is one of the noblest of all trees and many romantic legends are attached to it.

The Plane-tree was known in the earliest records of Greece. Herodotus tells that Xerxes, when he invaded Greece, was so enchanted with a beautiful Plane-tree that he encircled it with a collar of gold and confided the charge of it to one of his Ten Thousand. Ælians adds that Xerxes passed an entire day under its shade, compelling his whole army to encamp nearby and that this delay was one of the causes of his defeat. He was so fond of this tree that he covered it with gold and gems, styled it "his mistress, his minion, his goddess", and for several days was entirely oblivous to his expedition and army (Loudon 1844).

In the time of Pliny, Plane-trees were planted near all the public schools in Athens. Pliny says that there is "no tree whatsoever which so well defends us from the heat of the sun in summer". We are told that the grooves of Epicurus, in which Aristotle taught his roving disciples, the groves of Academus, in which Plato delivered his celebrated discourses, and the shady walks planted near the Gymnasia and other public buildings of Athens, were all composed of this tree. Homer frequently mentions "the shady Plane". Socrates swore by the Plane-tree, and this was one of the things that offended Melitus, who thought it a great crime to swear by so beautiful a tree. (Loudon 1844).



Fig. 6. *Platanus Kerri.*

The Plane-tree was also cultivated in Iran from the earliest period, and is still one of the most conspicuous features of its landscape. The Romans were long attracted to this precious and beautiful tree of the Levant. We are told how Licinius Mucianus, when Roman Consul in Lycia, dined in its hollow trunk along with eighteen persons of his retinue. It was introduced into Italy from Greece about 390 B. C. and the Romans planted it extensively in their gardens for shade.

The Oriental Plane seems to have been introduced into England as an ornamental tree about the middle of the 16th century, the exact date being unknown. It was introduced into France from England in about 1754 and into North America apparently in colonial times, although the exact date can not be ascertained.

However, at the present, aside from the Mediterranean region, the Oriental Plane is little planted because of its tenderness. It is now un-

common in Great Britain, where it was replaced by the London Plane more than 150 years ago. However, there are scattered fine old specimens of large size of this species planted some 300 years ago in England (Elwes & Henry 1908).

### The Oriental Plane in North America

There seems to be no record extant fixing the date of introduction of the Oriental Plane into North America. Although the Oriental Plane sometimes figures deceptively as an important tree of frequent occurrence in this country, actually it is at present extremely rare in cultivation. What is generally called *"Platanus orientalis"* or "Oriental Plane" in the trade and in the literature nearly always proves to be the London Plane, *P.* × *acerifolia*. The Oriental Plane is indeed one of the most confused plants in horticulture.

This confusion seems to stem from the early concept of considering the London Plane as a variety of the Oriental Plane. Many authors in the past called the London Plane, simply *"P. orientalis"*, without indicating that actually it was meant for *"P. orientalis* var. *acerifolia"*. Though as early as 1908, Henry pointed out clearly that the London Plane, widely planted in the United States, was invariably known by the erroneous name of *"P. orientalis"*, such a confusion in the names persists to this day in the literature. In 1916 Rehder (in Bailey 1916) noted that "The true oriental plane is rare in cult., the tree usually planted under this name being *P. acerifolia*". Henry also stated in 1919 that the Oriental Plane, which is not readily propagated by cuttings, was never used for planting in streets in Europe or North America, and that it was very rare in the latter region.

In a recent work, Wyman (1951)[1] recommends both *P. orientalis* and *P.* × *acerifolia* as trees for American gardens and states that both are planted annually as a street tree by the thousands and that both these species have been grown as clipped screens and arbors in this country. Despite inquiries from various sources, we have not been able to confirm these uses of *P. orientalis* in this country.

As a result of these inquiries and from a study of herbarium materials and the literature, we have come to note only a few alleged trees of *P. orientalis* in this country. In New York City, Croizat (1937) located four trees, two standing in Central Park, one planted in Morningside Park, and one cultivated in the Brooklyn Botanic Garden. He says that all of these are mature plants probably of the same age and same origin, although he gives no indication of either. An accompanying illustration and several preserved herbarium specimens show that these trees are probably correctly identified, although they may also be hybrids resembling more closely *P. orientalis*. He says that the leaves of the Oriental Plane vary bewilderingly. Actually some of the leaves of his Oriental Plane are very close to those of his London Plane given in the same illustration.



Fig. 7. *Platanus orientalis* (?), from planted tree, Verree Road.

In the city of Philadelphia, no less than 158,000 trees are planted along the sidewalks.[2] According to Mr. W. B. Satterthwaite, principal arboriculturist of the city, 50,000 are Plane-trees, and all except two, are London Planes. The two exceptions are probably Oriental Plane, growing along

[1] In Wyman's book, there is mention of trees of *P. orientalis* in New England said to be three or four hundred years old. Upon inquiry, Dr. Wyman admits this to be an error, stating that he meant England instead of New England.

[2] The street trees of Philadelphia are under the jurisdiction of the Fairmount Park Commission. I am indebted to Mr. Satterthwaite for information on the Plane-trees in Philadelphia.

Verree Road in the Fox Chase section of the city. (Fig. 7). Another tree of its kind growing nearby as a street tree is in the town of Ardmore, Pennsylvania.[3]

A resident along Verree Road informs us that the Plane-trees there were planted some twenty-five years ago from seedlings obtained from the nearby Krewson's Nursery. The two supposedly Oriental Plane-trees are somewhat distinct from the numerous other London Planes, being much more slender and more sparsely branched. The outer barks are nearly completely peeled off exposing the smooth silvery grayish inner bark. There are three to five fruiting heads to the cluster. The leaves are deeply 5-7-lobed, with the sinuses reaching below the middle of the leaves. As the trees are trimmed every year we are not aware of any frost-killing of the younger branches.

In addition to the three trees on the records of Fairmount Park, we have discovered a fourth tree, on Paper Mill Road just beyond the city limits near Chestnut Hill. This has the same kind of deeply and narrowly lobed leaves and smooth whitish bark. (Fig. 8). It is a larger tree than those on Verree Road, with the trunk approaching the size of the other London Plane-trees lining the street along with it. These trees are about the same size and age as those on Verree Road and were probably all planted about the same time. The tree along Paper Mill Road, however, bears fruits mostly in clusters of twos.

These four Philadelphia trees of supposedly Oriental Plane identity, like the trees of New York mentioned above, may not be pure *P. orientalis,* but hybrids of *P. orientalis* and *P. occidentalis.* However, instead of showing intermediate characters between the two parent species like most other London Planes, they resemble more closely the former parent. Our supposition is prompted in part by the fact that although the leaves of these trees approach very closely *P. orientalis,* the smooth whitish bark seems to resemble more *P. occidentalis* than it does the former. Without actual records of the origin of these trees, it is not possible to ascertain their true identity, and since these trees approach so closely the features of *P. orientalis,* even though they may be of hybrid origin, they may pass as that species for practical purposes in identification. These plants appear to be especially close to *P. orientalis* var. *cuneata,* which is considered by Henry (1919) as a variety of *P.* × *acerifolia.* (See further discussions under the London Plane.)

[3]Mr. Satterthwaite says that he obtained some cuttings from this tree ten years ago and was able to propagate several trees. One is quite large now and is growing at the west end of site of Horticultural Hall. Cuttings from the other two trees had not proved successful.



Fig. 8. *Platanus orientalis* (?), from planted tree, Paper Mill Road.

In recent years there have been several efforts made in this country to introduce authentic stocks of *P. orientalis* from Europe and the Orient. The Morris Arboretum received in 1954 seed from three sources, from Kashmir through Mrs. Laura Barnes, from Turkey through Dr. Frank Meyer, and from Italy through Dr. Benjamin Blackburn. A number of seedlings were raised but all perished either in the greenhouse or when outplanted except one in the nursery which is now about two feet high. This tree is from seed obtained from Italy. (Fig. 3).

## The American Plane

In eastern North America, *Platanus occidentalis* occupies a very wide range from Maine to Ontario westward to Minnesota and southward to Florida and Texas. Within the region it is a common tree, inhabiting especially the borders of streams and lakes and rich bottom-lands. A variety *glabrata,* with smaller, more deeply lobed leaves, but considered as indistinct by some botanists, occurs in central Iowa and Missouri to western Texas and northern Mexico.

The American Plane, attaining to a height of 140-170 feet is, according to Sargent (1895), the most massive if not the tallest deciduous-leaved tree of the North American forest. It is a taller tree than the Oriental Plane and, like the latter, it lives to a great age.

The American Plane can be distinguished from the Oriental Plane by the bark, the leaves, and the fruiting heads. The bark peels off in small thin scales, exposing the large irregular surfaces of almost creamy white instead of flaking in large pieces revealing a dull grayish or greenish white beneath as does the Oriental Plane. The leaves of the American Plane are 3- or sometimes 5-lobed with broad-triangular lobes which are broader than long; while in the Oriental Plane, the leaves are deeply 5-7-lobed, the lobes being narrow, longer than broad, with the sinuses reaching to below the middle of the leaves. (Figs. 2, 3 and 4). In the American Plane, there is generally a single fruiting head borne on a stalk, rarely two together, while in the Oriental Plane, there are 2-7 fruiting heads together. In the American Plane, the old stigmas of the individual achenes are much shorter and consequently the head is much smoother and not as bristly. The achene has a flat or slightly rounded apex while in the Oriental Plane the achene is not only more bristly but always more or less conical or tapering.

The American Plane, known also as Buttonwood or Sycamore, has been planted since the 16th century as an avenue tree or shade tree. It was introduced into English gardens by the younger Tradescant early in the 17th century (Loudon 1848). In England and on the European continent, it is not suited to the climate. Elwes & Henry stated in 1908 that so far as they know there was not a single tree of this species of any size growing in Britain. And the tree was equally rare on the continent; only a few trees were then known to exist in France and none in Germany or Austria. Henry also stated that although seedlings were frequently raised at Kew, they never lived more than a few years and suffered severely from frosts and diseases.

The Plane-trees are especially desirable as street trees because of their ability to withstand smoke and the absence of insect pests, but the American Plane is now little used even in America because it is often severely subject to a blight, also known as anthracnose, caused by a fungus *Gnomonia venera*. The Oriental Plane appears to be practically immune from the attack of this fungus. The London Plane, the history of which we will presently investigate, is almost invariably affected, but to a much lesser degree than the American Plane.

In the horticultural literature of England and Europe, the American Plane, often known as Occidental Plane, is frequently confused with the London Plane, *P.* × *acerifolia*. As pointed out by Elwes and Henry (1908) the confusion between these two plants seems to have begun early and persisted tenaciously. In the opinion of these authors, it is probable that most of the references to the "Occidental Plane" in Great Britain and on the continent of Europe actually refer to *P.* × *acerifolia*.

*(To be continued)*

# Spring Flowering Calendar

John M. Fogg, Jr.

By the time this issue reaches its readers a score or so of plants will already have come into flower at the Arboretum. In some cases the blooms will have appeared and gone; in others, with a more prolonged flowering season, there may still be a show of color.

Included in this group of hardy pioneers, which may be counted on to form the vanguard of late winter and early spring, are the following: the Vernal Witch Hazels *(Hamamelis vernalis, H. japonica, H. mollis* and *H. intermedia);* the Silver and Red Maple *(Acer saccharinum* and *A. rubrum,* which usually flower in mid and late February respectively); the early Dogwoods or Cornelian Cherries *(Cornus officinalis* and *C. mas);* the Wintersweet *(Chimonanthus praecox*); Winter Jasmine *(Jasminum nudiflorum);* several of the early honeysuckles *(Lonicera Standishii, L. Perpusi* and perhaps *L. fragrantissima);* Spice Bush *(Lindera Benzoin)* and, possibly, two of the earliest Rhododendrons of the Azalea group *(Rhododendron mucronulatum* and *R. dauricum).*[1]

Some of these, like the dogwoods, witch hazels and honeysuckles, may respond to a warm spell almost any time during the winter months, although persistent cold weather may prevent the first appearance of their flowers until late February or March. Others, like the maples, seem to

[1]For a fuller discussion of this subject see "Early Flowering Shrubs at the Arboretum" by Martha H. Starr, Vol. 7:12-13 (1956).

be more delicately adjusted to the length of day and the angle of the sun's rays and usually come into bloom on about the same date regardless of temperature. Indeed, the whole subject of phenology, or the relation of plants to weather, is a fascinating one and deserves a great deal of study at the hands of persons who are in a position to conduct observations on both wild and cultivated plants.

Records maintained in this area over a series of many seasons indicate that, in general, most plants can be expected to come into flower on about the same date year after year. Exceptions occur, of course, and during the unusually cold winter and spring of 1956 many plants were as much as two or even three weeks behind schedule.

The following list attempts to express week by week the flowering expectancy during April and May of a number of trees and shrubs found growing at the Arboretum. It has no pretentions to completeness or exactness, but is offered merely as an indication of the dates by which, based on past performance, some of the more familiar plants in the Arboretum may be expected to put forth their first flowers. It is hoped that visitors to the grounds will find it a useful guide. We shall welcome any corrections or additions which they care to pass on to us. It should be recognized that there may well be a difference of several days between blooming dates at the Arboretum and those of localities at a lower altitude even within a radius of a few miles.

## BLOOMING DATES

APRIL

*First week*

| | |
|---|---|
| Pussy Willow | Salix discolor |
| Goat Willow | S. caprea |
| Star Magnolia | Magnolia stellata |
| Winterhazels | Corylopsis spicata C., sinensis, etc. |
| Japanese Andromeda | Pieris japonica |
| Forsythia, Golden Bells | Forsythia ovata |

*Second week*

| | |
|---|---|
| Hybrid Magnolias | Magnalia Soulangeana, etc. |
| Kobus Magnolia | Magnolia Kobus |
| Oregon Grape | Mahonia Aquifolium |
| Shad-bushes | Amelanchier spp. |
| Flowering Quince | Chaenomelas lagenaria |
| Weeping Cherry | Prunus subhirtella pendula |
| Yoshino Cherry | Prunus yedoensis |
| Japanese Spurge | Pachysandra terminalis |
| Periwinkle, Ground Myrtle | Vinca minor |

*Third week*

| | |
|---|---|
| Oriental Cherry | Prunus serrulata |
| Thunberg Spiraea | Spiraea Thunbergii |
| Bridal Wreath | Spiraea prunifolia |
| Red-bud, Judas Tree | Cercis canadensis |
| Ohio Buckeye | Aesculus glabra |
| Silver Bell | Halesia monticola |
| Enkianthus | Enkianthus perulatus |
| Royal Azalea | Rhododendron Schlippenbachii |
| Carles' Viburnum | Viburnum Carlesii |

*Fourth week*

| | |
|---|---|
| Kerria | Kerria japonica |
| Wisterias | Wisteria spp. |
| Hardy Orange | Poncirus trifoliata |
| Flowering Dogwood | Cornus florida |
| Kurume Azaleas | Rhododendron obtusum |
| Snow Azalea | R. mucronatum |
| Skinner Hybrid Azaleas | R. spp. |
| Lilacs | Syringa spp. |
| Tartarian Honeysuckle | Lonicera tatarica |

MAY

*First week*

| | |
|---|---|
| Jet-bead Shrub | Rhodotypus kerrioides |
| Pearl Bush | Exochorda racemosa |
| Fringe Tree | Chionanthus virginica |
| Japanese Snowball | Viburnum tomentosum |
| Tree Peonies | Paeonia suffruticosa |
| Neviusia | Neviusia alabamensis |
| Glenn Dale Hybrid Azaleas | Rhododendron spp. |

*Second week*

| | |
|---|---|
| Cucumber Tree | Magnolia acuminata |
| Flowering Crabs | Malus spp. |
| Neillia | Neillia sinensis |
| Van Houtte's Spiraea | Spiraea Van Houttei |
| Black Locust | Robinia pseudoacacia |

*Third week*

| | |
|---|---|
| Umbrella Tree | Magnolia tripetala |
| Sweetshrub | Calycanthus floridus |
| Mock Oranges | Philadelphus spp. |
| Yellow Wood | Cladrastis lutea |
| Princess Tree | Paulownia tomentosa |
| Leucothoe | Leucothoe editorum |
| Weigelias | Diervilla spp. |

*Fourth week*

| | |
|---|---|
| Deutzias | Deutzia gracilis, D. parviflora, etc. |
| Ninebark | Physocarpus opulifolius |
| Mountain Ash | Sorbus americana |
| Horse-chestnut | Aesculus Hippocastanum |
| Butterfly Bushes | Buddleia spp. |
| Beauty Bush | Kolkwitzia amabilis |

Although the species on the above list are all woody, it is worth pointing out that there are many herbaceous plants in the Arboretum that merit observation. The Snowdrops *(Galanthus)*, the Snowflakes *(Leucojum)* and some of the Squills *(Scilla)* usually start flowering in February and may continue until the middle or the end of March. Grape Hyacinth (Muscari) is another early bloomer which makes a fine showing in the woodlands along the Wissahickon in March.

Early April marks the appearance of Narcissus with its infinite variety of color forms. Some of the plants in the Rock Wall around the Rose Garden begin flowering in mid April and by early May the three sides of this wall garden display a riot of color.

# Cultivated Firs in the Philadelphia Area

Jonathan W. Wright[1]

The genus *Abies* (fir) is one of the largest of the coniferous genera. It contains about 50 species, distributed from Guatemala to northern Canada in the New World, and from northern Africa to Siberia in the Old World. Along the Pacific Coast of North America some species descend to low elevations in temperate climates, but most of the firs grow in relatively inaccessible mountain areas. Only the northern species have extensive, continuous lowland ranges.

In the Old World the firs are relatively unimportant commercially because of their inaccessability and because their light, weak wood is unsuited for uses requiring much strength. Several of the New World species are important producers of high-grade pulp used in products such as newsprint, rayon, and cellophane. As the forest economy in a fir-growing region changes from lumber production to pulpwood production, the relative economic importance of the firs in that region increases. This trend will probably continue because the shade-tolerance of the firs causes them to increase in relative amount after logging of the lumber-producing species.

To most laymen, and perhaps to many economists, the firs are most important as Christmas trees. Indeed, it was the European silver fir (*Abies alba* Mill.) that gave its name to the Christmas carol *"O Tannenbaum."* The balsam fir (*A. balsamea* (L.) Mill.) is the premier Christmas tree in the Northeast, where over 6,000,000 were cut in 1955 (Sowder, 1956). Other species of fir are used as Christmas trees in the western United States.

The balsam fir furnishes two unique products — Canada balsam and balsam pillows. Canada balsam is a pitchy substance derived from bark blisters. It owes its commercial importance to its transparency and to its index of refraction, which is nearly the same as that of glass. These properties make it ideal for the preparation of microscope slides and the cementing of microscope and camera lenses. Balsam pillows are prepared from balsam fir needles. They cannot compete with feather or foam rubber pillows in softness, but they do have a delicious fragrance that lasts for years.

The firs have several characteristics that make them valuable for landscape plantings, especially on large lots. They have dense, dark, evergreen foliage; they have narrow, pyramidal crowns; they grow better than most other conifers in the shade; and they are hardy and relatively free from pests. The stately Greek fir (*A. cephalonica* Loud.) makes an excellent specimen tree; so do many other European and Japanese species. The wide-spreading Nikko fir (*A. homolepis* Sieb. and Zucc.) can be used as a specimen tree or as a shade tree. Because of their ability to grow in dense shade, several species are ideal for planting under existing deciduous trees to brighten up an otherwise drab winter landscape. Under such conditions the firs grow more slowly than they would in the open, but they will live for years and grow into big trees if the overhead shade is removed.

## Taxonomic Characteristics

Fir needles are of medium length (½ to 2½ inches long); they are borne singly; they are usually blunt and bifid at the apex; they are usually flattened; with stomata only on the lower surface; and they are all of approximately the same length. The cones are erect; they fall apart while on the tree, leaving the central axis for years as a mute reminder of past seed-bearing; they are borne only on the uppermost branches. One or more of these characteristics may be used to distinguish fir from pine (needles borne in groups of 2 to 5 cones borne on middle or lower branches as well as upper branches); spruce (sharp needles, pendant cones); hemlock (short needles of varying lengths, small cones borne over entire crown); Douglas-fir (pendant cones born over entire crown), and other common conifers.

Distinguishing one fir from another would be an easy task if we knew the geographic origin of each specimen because there is usually one and only one species in a given native fir forest. Unfortunately, data on seed origin are almost always lacking. Therefore we must use cones or twigs for identification. The cones contain many good diagnostic characters but they are usually out of reach on tall trees. When using twig material for identification it is necessary to pay close attention to details such as degree of pubescence,

[1]The author is Geneticist, Northeastern Forest Experiment Station, U. S. Forest Service, Upper Darby, Pa. He is stationed at the Morris Arboretum, where many of the observations recorded in this paper were made, in cooperation with the University of Pennsylvania.

needle arrangement, number of lines of stomata, resin on the buds, and general vigor of the tree. There are a few species that have one or two characteristics that are distinctive enough for easy and positive identification. Among such species in Philadelphia are balsam fir (low vigor), Nikko fir (broad crown, grooved branchlets), Spanish fir *(A. Pinsapo* Boiss.; entire, sharp-pointed needles), Momi fir *(A. firma* Sieb. and Zucc.; bifid, sharp-pointed needles), and cork-bark fir *(A. lasiocarpa* (Hook.) Nuttall var *arizonica* (Merriam) Lemmon; blue foliage).

### Performance in the Philadelphia Area

In a brief paper such as this it is impossible to do more than mention the highlights of the most important species. Therefore Table 1 was prepared to give growth information about all species that have been tested in Philadelphia, Pa., or Rochester, N. Y.[2] In general the correspondence between observations made on the same species in Philadelphia and in Rochester has been great enough to make it possible to use the observations interchangeably.

The reader interested in the performance of exotic firs in other sections of the Northeast is referred to papers by Sargent (1898), Slavin (1932), and Harkness (1953).

Nomenclature in this paper follows Rehder (1949), Little (1953), or Martinez (1953) whenever possible. The references to *A. equi-trojani* Aschers. and Sint. and to *A. sikokiana* Nakai were taken from Mattfeld (1926) and Hayashi (1951) respectively.

### Geographic Origin and Growth in the Northeast

The most logical way to classify the firs is by geographic origin. Except in Japan the species from any particular region tend to be more similar to each other in taxonomic characteristics than they are to species from other regions. For example, the presence of stomata on the upper leaf surface is limited mostly to species from western America, grooved branchlets are found only in three species from eastern Asia, and cones more than 5 inches long are found principally in species native to the Mediterranean basin.

This similarity among species from the same geographic region applies to growth as well as to taxonomic characteristics. For that reason, it is possible to generalize as has been done in the following tabulation:

| *Region of origin* | *Growth rate and general appearance in Philadelphia or Rochester* | |
|---|---|---|
| | *Growth* | *Appearance* |
| Eastern United States | Slow | Poor |
| Rocky Mountains | Moderate | Good |
| Western United States | Slow | Good |
| Japan | Rapid | Good |
| Northern Eurasia | Slow | Poor |
| Mediterranean Basin | Rapid | Good |

### The American Firs

White fir *(A. concolor* (Gord.) Hoopes) is the most commonly planted species of fir (Fig. 9). It is found in towns and cities throughout Pennsylvania and New York. This species is the most vigorous of the American firs in Philadelphia, and Harkness (1953) regards it as the most reliable of all firs for the Rochester area.

The white fir has a large natural range in the Rocky Mountains and the Sierra Nevadas, where it grows up to 250 feet tall. It is very likely that the Sierra Nevada population should be considered as a distinct geographic variety, *Abies concolor* var. *Lowiana* (Gord.) Hoopes. Trees from



Fig. 9. The light blue green foliage of the white fir contrasts with the dark green of other evergreens.

[2]Many of the measurements of Rochester trees were made by Bernard Harkness, Rochester Park Department.

Table 1. *Maximum sizes and growth rates of individual open-grown specimens or fir growing in Philadelphia, Pa., and Rochester, N. Y.*[1]

| Common name | Scientific name, *Abies*— | Trees measured | Age | Total height | Height growth per year | Diameter breast high | Where seen[2] |
|---|---|---|---|---|---|---|---|
| | | *Number* | *Years* | *Feet* | *Feet* | *Inches* | |
| **UNITED STATES AND CANADIAN FIRS** | | | | | | | |
| Balsam | *balsamea* | 26 | 29 | 28 | 0.9 | 8 | HR*W* |
| Fraser | *Fraseri* | 3 | 48 | 20 | .4 | 6 | *W* |
| White | *concolor* | 41 | 60 | 70 | 1.2 | 24 | HM*R*W |
| Subalpine | *lasiocarpa* | 10 | 55 | 53 | 1.0 | 12 | HM*R*W |
| Corkbark | *l.* var. *arizonica* | 3 | 15 | 13 | .8 | 4 | HM*R* |
| California red | *magnifica* | 1 | 20 | 2 | .1 | — | W |
| Noble | *procera* | 7 | 50 | 18 | .4 | 5 | R*W* |
| Grand | *grandis* | 2 | 5 | 3 | .6 | — | *W* |
| Pacific silver | *amabilis* | 2 | 19 | 9 | .4 | 2 | R*W* |
| **MEDITERRANEAN FIRS** | | | | | | | |
| Silver | *alba* | 7 | 15 | 6 | .4 | — | *H*RW |
| Weeping silver | *a.f. pendula* | 2 | — | 24 | — | 4 | *M*R |
| Nordmann | *Nordmanniana* | 16 | 35 | 55 | 1.6 | 13 | HM*R*W |
| Cilician | *cilicica* | 10 | 30 | 58 | 1.9 | 14 | MR*W* |
| Greek | *cephalonica* | 16 | 50 | 75 | 1.5 | 26 | HM*R*W |
| Spanish | *Pinsapo* | 3 | 20 | 7 | .3 | — | *W* |
| ——— | *Borisii-regis* | 1 | 9 | 6 | .7 | — | *H* |
| Algerian | *numidica* | 8 | 28 | 58 | 2.1 | 14 | H*W* |
| **JAPANESE FIRS** | | | | | | | |
| Sakhalin | *sachalinensis* | 3 | 34 | 27 | .7 | 7 | *R* |
| Veitch | *Veitchii* | 29 | 43 | 44 | 1.0 | 14 | HM*R*W |
| Maries | *Mariesii* | 6 | 22 | 29 | 1.3 | 6 | M*W* |
| Momi | *firma* | 9 | 22 | 21 | 1.0 | 5 | H*W* |
| Nikko | *homolepsis* | 28 | 30 | 43 | 1.4 | 11 | HM*R*W |
| **SIBERIAN AND KOREAN FIRS** | | | | | | | |
| Korean | *koreana* | 3 | 42 | 17 | .4 | 5 | *R*W |
| Siberian | *sibirica* | 2 | 48 | 50 | 1.0 | 9 | *R*W |
| Khingan | *nephrolepis* | 2 | 30 | 29 | 1.0 | 7 | *R*W |
| Needle | *holophylla* | 7 | 30 | 30 | 1.0 | 8 | *M*W |
| **CHINESE FIRS** | | | | | | | |
| Farges | *Fargesii* | 1 | 11 | 5 | .4 | — | *R* |
| Ernest | *Ernesti* | 2 | 29 | 40 | 1.3 | 7 | *R* |
| Min | *recurvata* | 3 | 40 | 27 | .7 | 7 | *R* |

[1]Data are not available for the following species: *A. venusta* (United States); *A. durangensis, A. guatemalensis, A. Hickeli, A. Vejari, A. mexicana, A. oaxacana, A. religiosa* (Mexico); *A. marocana* (Morocco); *A. Borisii-regis* (Greece); *A. nebrodensis* (Sicily); *A. Bornmuelleriana, A. equi-trojani* (Turkey); *A. sikokiana* (Japan); *A. Pindrow* (Himalayas); *A. Kawakamii* (Formosa); *A. squamata, A. sutchuensis, A. Faxoniana, A. Georgei, A. Fabri, A. Delavayi*, and *A. chensiensis* (western China). The small, continuously frosted specimen of the Himalayan *A. spectabilis* mentioned by Slavin (1932) in Rochester is no longer living.

[2]H=Haverford College, Haverford, Pa.; M=Morris Arboretum, Philadelphia, Pa.; R=Durand Eastman and Highland Parks, Rochester, N. Y.; W=Westtown School, Westtown, Pa. Italics show the Arboretum in which the largest tree is located.

the Rocky Mountains are preferable for planting in the Northeast because most ecotypes and species from the Pacific Coast states are unsatisfactory here.

Several specimens on the grounds of the former H. W. Sargent estate at Beacon, N. Y., (on the lower Hudson River) testify that the white fir can become a large tree in the East. These are about 80 years old. The largest is 82 feet tall, 25 inches in diameter, and is still thrifty. Some of the specimens in the Rochester public parks are almost as large.

The subalpine fir (*A. lasiocarpa* (Hook.) Nutt.) grows naturally at high elevations in the Rocky Mountains from New Mexico to Alaska and in the Cascade Mountains of Oregon and Washington. In its native habitat its tall, spire-like crown makes it a distinctive feature of the mountain landscape. It retains this spire-like crown when planted in the East.

The corkbark fir (Fig. 10) from the southern Rocky Mountains is usually considered as a geographic variety of the subalpine fir, but is quite different from that species in color and form. Its foliage is almost as blue as is that of the blue spruce. This tree grows very slowly, and is useful for foundation plantings and small gardens.

The balsam fir has the largest natural range of any of the firs — from West Virginia north to Newfoundland and westward across Canada nearly to Alaska. However, it seems to be one of the most unsatisfactory species for planting outside its natural range. Even in Williamstown, Mass., just a few miles from native stands, planted balsam firs have grown more slowly than three exotic species planted at the same time. Living specimens in Philadelphia and Rochester are characterized by short, sparse foliage totally unlike that of wild trees.



Fig. 10. The slow-growing corkbark fir has the bluest foliage of the firs.



Fig. 11. Nordmann fir is very resistant to damage by late spring frosts.

### Mediterranean Basin Firs

The firs of the Mediterranean basin have an interesting pattern of geographic distribution. Eight of the species have separate ranges. Only in parts of Greece is there slight overlapping, which involves three species. Five of the species have ranges that are smaller than some Pennsylvania counties. In several instances the taxonomic differences between species are proportional to the distance between the species. A distribution and variation pattern such as this is characteristic of groups that have evolved in place from a common ancestor and in which geographic isolation has been a major factor in promoting species differentiation.

The Greek fir grows at elevations of 2,700 to 5,500 feet in the mountains of Greece. Rapid growth, dark-green foliage, and a dense crown make the Greek fir one of the best of the exotic

species for planting in Philadelphia. It has been distributed by several nurseries, and there are many large specimens in arboreta and private estates. In its native forests the Greek fir reaches heights of 90 to 100 feet. It promises to do almost as well in this country; an 80-year-old specimen on the former Wodlet estate near Beacon, N. Y. is 82 feet tall, 27 inches in diameter, and still growing vigorously. This species has proved quite hardy in the Boston area (Sargent, 1898), but has suffered slight winter-burning in Rochester (Harkness, 1953).

Cone-collecting in Greek fir is apt to be a major undertaking. The cones are large and resinous. Also, they are borne only on the uppermost branches, within 2 or 3 feet of the top of the tree, somewhat above the safe climbing limit.

If the top of a vigorous Greek fir is broken or cut off, several small trunks develop in its place. The Greek natives in isolated mountain districts use this characteristic to good advantage, harvesting the small trunks of injured trees for local construction work.

The Nordmann fir (*A. Nordmanniana* (Steven) Spach) is a native of the western Caucasus and the mountains of northeastern Turkey (Fig. 11). There it grows with oriental spruce and other high altitude species. It has dark-greeen foliage and a very dense crown. The needles spread outward and forward, almost hiding the twig from sight. This species should make an excellent Christmas tree as well as a good specimen tree.



Fig. 13. Injury to the top caused some of the lower branches to ascend in this Cilician fir. The ascending branches have many of the characteristics of trunks, and bear cones.



Fig. 12. The Cilician fir finds itself as much at home as does the Lebanon cedar with which it grows naturally.

In western Turkey there are two little-known firs, *A. Bornmuelleriana* Mattf. and *A. equi-trojani*, that are perhaps best regarded as intermediates between the Greek and Nordmann firs (Mattfeld, 1926). These species should be tried in the Philadelphia area as soon as possible.

The Cilician fir (*A. cilicica* Anat. and Kotschy) is similar to the Nordmann fir in general appearance and growth rate (Figs. 12 and 13). It is a native of southern Turkey and northern Syria, where it often grows with the cedar of Lebanon. This species is found in most arboreta and in many private estates. It makes a good specimen tree and should be acceptable as a Christmas tree.

The silver fir has the largest natural range of any of the European species. It grows on high mountains from the Pyrenees to central Germany and south to the toe of Italy and Rumania. In Greece it seems to cross with the Greek fir, forming the intermediate species *A. Borisii-regis* Mattf. (Mattfeld, 1926). The silver fir has not been so satisfactory in the Northeast as have the other Mediterranean basin species. Perhaps this is due to the use of improper seed origins (presumably the southern origins would be the best);

a few Philadelphia specimens are full-crowned whereas others are very unthrifty.

The Algerian fir (*A. numidica* DeLannoy ex Carr.) is an example of a limited-range endemic species that grows rapidly when transferred to a different part of the world. Its natural range covers only a few square miles on Mt. Babor, Algeria (Mattfeld, 1926), but it promises to be the fastest growing fir in the Philadelphia area. It possesses great promise as a Christmas tree because of its pyramidal form and because of the great color contrast between the lower (whitish) and upper (dark green) leaf surfaces. A nurseryman sent in a specimen for identification recently. He has been selling cut branches from specimen trees for Christmas greens. The demand for these greens is now so great that he wishes to establish special Christmas green plantings. If he plants more than a few acres, he may well double the number of trees in existence!

### Japanese Firs

Unlike the Mediterranean species, the Japanese firs have overlapping ranges. In fact, four of the six species occur on one mountain in central Honshu. Most of the Japanese species are taxonomically more different from each other than are species with adjacent or overlapping ranges in other parts of the world. Such a distribution and variation pattern is characteristic of groups in which the species evolved separately elsewhere (in China in this instance?) and moved to their present ranges only after they were distinct enough to be unable to cross readily with each other.



Fig. 14. The Nikko fir has a dense, broad crown.

The Nikko fir (Fig. 14) from central Honshu and Shikoku is the most commonly planted of the Japanese firs. This species is known to be hardy in the Berkshire Mountains of western Massachusetts. On the Cluett estate near Williamstown, Mass. there are three 35-year-old specimens which are growing rapidly and show no signs of winter injury.

The Nikko fir has a broader and less dense crown than most firs. The crowns are usually ½ to ⅔ as broad as tall; one Morris Arboretum specimen is broader than tall. In some trees the lower branches are shorter than the upper branches.

The Veitch fir (*A. Veitchii* Lindley) was named after J. G. Veitch, a pioneer English plant explorer and nurseryman, who brought seeds of it back from Mt. Fujiyama in 1861. It grows on a few mountains in central Honshu. In the leaves of the Veitch fir there is a marked color contrast between the upper and lower surfaces. This characteristic and its pyramidal crown make it an excellent Christmas tree or specimen tree.

The Maries fir (*A. Mariesii* Mast.) and the Momi fir are known in Philadelphia from only a few arboretum specimens. Both are doing well and can be recommended for Christmas trees or lawn trees. The Sakhalin fir (*A. sachalinensis* Mast.) from Sakhalin and the Kurile Islands grows slowly and is thin-crowned in Philadelphia.

### Other Asiatic Firs

The needle fir (*A. holophylla* Max.) derives its common and scientific names from its long, entire, sharp needles (Fig. 15). In fact, one could easily mistake it for a spruce after a quick brush against the foliage. It has an open, regular crown, and does well in a variety of situations.

The Siberian fir (*A. sibirica* Ledeb.) has a wide range across Siberia. Strangely, it suffers from late frost damage when planted in lowland parts of the Northeast. This is a common failing in northern species that are moved southward. They have become adapted to a short season, and start to grow at the first hint of warm weather. However, I have seen one satisfactory plantation of this species, at an elevation of 1,100 feet near Forestville, N. Y. Rather, I saw the remnants of the planting, for most of the trees had been sold.



Fig. 15. The needle fir would make an excellent Christmas tree.

The owner, Mr. F. E. Stewart, reported that the Siberian fir had grown a little faster than white fir, had suffered occasional frost damage, and had been as salable as white, balsam, and Fraser firs planted at the same time.

E. H. Wilson was a plant explorer who traveled widely in western China during the early part of this century. The specific epithet *Wilsonii* is common, but rarely do we find Wilson's first name used as in the Ernest fir *(A. Ernesti* Rehd.) This species has a relatively small range in the Tatu River watershed of Sikang. It is very thrifty in Rochester and has a narrow pyramidal crown.

### Where to Obtain Fir Seed and Planting Stock

The availability of fir seed and planting stock is shown in Table 2. Some species not listed in that table may be available occasionally from small nurseries that do not publish catalogues.

When ordering seed it is well to specify that the seed be fresh (fir seed does not store as well as that of most other conifers), that the seed be collected within the native range of the species, and the geographic origin of the seed be shown on the label. Knowing the geographic origin is one of the best ways of guaranteeing the true identity of the seed. For example, one dealer lists Nordmann fir seed of central European and southern European origins. Because this species grows only in Asia Minor, the seed is probably not true to name.

Table 2. — *Numbers of nurseries and seedhouses handling species of fir, 1951 to 1956*[1]

| Species, *Abies* — | Nurseries | Seedhouses |
|---|---|---|
| | *Number* | *Number* |
| AMERICAN SPECIES | | |
| *balsamea* | 8 | 3 |
| *Fraseri* | 3 | 1 |
| *concolor* | 4 | 7 |
| *lasiocarpa* | 2 | 3 |
| *lasiocarpa* var. *arizonica* | 1 | 0 |
| *magnifica* | 0 | 3 |
| *procera* | 0 | 2 |
| *grandis* | 1 | 4 |
| *amabilis* | 0 | 3 |
| MEDITERRANEAN SPECIES | | |
| *alba* | 1 | 2 |
| *Nordmanniana* | 2 | 2 |
| *cilicica* | 0 | 2 |
| *cephalonica* | 1 | 2 |
| *Pinsapo* | 1 | 2 |
| *numidica* | 0 | 2 |
| JAPANESE AND KOREAN SPECIES | | |
| *sachalinensis* | 0 | 1 |
| *Veitchii* | 2 | 2 |
| *holophylla* | 2 | 0 |
| *Mariesii* | 0 | 2 |
| *Firma* | 0 | 2 |
| *homolepis* | 0 | 2 |

[1]This list was compiled from American nursery and seed catalogues in the library of the Morris Arboretum.

As a general rule, it is well to avoid seed collected from specimens planted in this country. This is especially true with regard to the rare species. Most of the large, fruiting firs are so isolated that they receive very little cross-pollination. The few filled seeds produced (usually less than 5 percent) on these isolated trees are probably the result of selfing (which gives trees of low vigor) or of crossing with other species.

Persons interested in large numbers of seedlings of uncommon species would do well to contract with a nurseryman experienced in growing coniferous stock for the production of the seedlings. They can be raised under much the same conditions as spruce save that the seed should be fall-sown and the seedbeds should be given extra shade during the first year and possibly part of the second year.

There has been very little vegetative propagation work done on the firs. Air-layering is probably the surest way of producing a few trees of species for which seed is not available.

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# Arboretum Activities

*(Continued from page 2)*

means that the branches of many of the smaller conifers and some broad-leaved evergreen shrubs must be bound up so that they look like Christmas trees loaded on a freight car for shipment. This prevents serious injury at time of heavy wet snowfalls or ice-storms. The rose garden must be mulched with a thick layer of straw and manure. A mulch must also be applied to any new beds which it is planned to dig during the winter, for such an application keeps the soil beneath from freezing and makes it possible to get a head start with spring planting operations.

Winter is, above all, a time for "housecleaning." The dead branches of evergreens may now be removed and the pruning of deciduous trees and such shrubs as are not early bloomers accomplished. The hundreds of plants in the rose garden are severely pruned. Dead or dying trees are taken down, the trunks and large limbs cut into sections and the litter transported to the dump heap.

Repairs to service roads consume a considerable amount of time and effort. Painting and minor repairs to greenhouses and other buildings engage the full time services of two members of the staff. Machinery must be overhauled: spray pumps cleaned, tractors and grass-cutting equipment put into shape, cutting tools sharpened. Pots must be washed and stored according to size, ready for instant use in the spring.

A certain amount of planting is carried on all during the dormant months. This is especially true in areas where, as indicated above, the ground is covered with a mulch. For example, a strip designed to accommodate a new planting of Glenn Dale azaleas was so treated in November, the bed was dug and prepared in February and the plants set out in March. It is fully expected that these azaleas will produce a goodly display of color this May. Such an accomplishment would be impossible if we accepted winter as a period of suspended animation.

The dormant months are also a time when a substantial amount of propagation can be initiated. Seeds of many plants are started in winter and hardwood cuttings of evergreens and flowering shrubs can be taken.

The making of labels is primarily a winter operation. Hundreds of new stainless steel labels are needed each year not only for plants which are added to the collection but also to replace labels which are stolen. Countless lead labels are also used to identify plants growing in the slathouse, cold frames and nurseries prior to being moved to their permanent positions on the grounds.

One of the most important undertakings in any arboretum is the careful maintenance of accurate records of all plants included in its collections. This means keeping for each specimen an individual file card on which is recorded its history from the day it is received here until the time when it dies and is taken down or removed. There are often as many as eight separate steps necessary in preserving a complete "pedigree" of each of the thousands of plants growing at the Morris Arboretum. Without the preservation of a precise and detailed history of the specimens in our collection, the kind of scientific work which goes on quietly here behind the scenes would be impossible. Among other winter undertakings, closely related to the maintenance of records, are the mapping of all sections of the grounds (which can best be conducted during the non-growing season) and the taking of inventory of all nursery stock.

It will be seen, therefore, that the winter months, instead of representing a period of hibernation at the Arboretum, are rather a season of intense activity.

J. M. F., Jr.

# Soil Acidity Preferences of Selected Woody Plants

Edgar T. Wherry[1]

As a result of the observations and writings of the late Frederick V. Coville, and many subsequent workers, horticulturists now generally realize that soil reaction, — that is acidity vs. alkalinity — is a factor that one must take into account in setting out plants. Collaborating with Dr. Coville for a number of years, the writer worked out methods for ascertaining the degree of acidity of soils in the field by the use of indicators, — dyes capable of changing their color in response to reaction. First published in 1920, this method has now come into general use.

At this point it may well be pointed out that, while it is true that acids taste sour, many so-called "sour" soils are not acid at all, but on testing with the indicators prove to be distinctly alkaline. The term sour is here being used, thus, in the sense of abnormal or distorted, like a sour note in music or a sour look one gives to a disliked person. For instance, the appearance of mosses in a grassy lawn does not necessarily mean that the soil is acid at all, — it is merely sterile. Before drawing any conclusions as to the reaction of individual sites, tests with indicators should always be made first.

Such tests show that in the general region of Philadelphia the soils are on the whole rather acidic in character, except in the limestone areas of the Whitemarsh-Chester Valley, where neutral conditions are more frequent. When setting out ornamental plants, it is manifestly desirable to select those adapted to the conditions of the specific site; but few dealer's catalogs furnish adequate information as to acidity preferences of individual sorts. At the request of the late Dr. Liberty Hyde Bailey, the writer contributed data as to species of horticultural interest for his work, Hortus, and these will be found in the first and second editions under the heading, Soils. As requests for more information are frequently received, however, some notes on observations of woody plants are here presented.

Should the soil of a given area show on testing a definitely acid reaction, the one woody plant group from which ornamentals will surely be selected is the Heath Family or Ericaceae. To this belong the numerous Rhododendrons — including Azaleas — together with various lesser genera, notably *Andromeda, Arctostaphylos, Calluna, Chimaphila, Clethra, Epigaea, Erica, Gaultheria, Gaylussacia, Kalmia, Ledum, Leiophyllum, Leucothoe, Lyonia, Menziesia, Oxydendrum, Pieris, Pyrola, Vaccinium,* and *Zenobia.* With minor exceptions, and in temperate climates, the species belonging to these genera thrive only in acid soils. If planted where the reaction is circumneutral — i.e., barely acid, neutral, or slightly alkaline, as is the case in cultivated land where lime, compost, commercial fertilizers, etc. have been applied — such plants soon develop "pattern-chlorosis." The leaves turn yellow, with only the tracery of the veins exhibiting the normal green. They may continue to bloom for a season or two, but before long weaken and die. Leafspots and other parasitic fungi, if by chance introduced, spread rapidly and hasten the process.

Some 30 years ago the Bulletin of Popular Information of the Arnold Arboretum carried a note to the effect that *Rhododendron roseum* differs from related species in growing in limy soil, so could well be planted in ordinary (non-acid) gardens. As this was wholly contrary to Dr. Coville's experience, he asked me to look into the matter. Professor Sargent stated that his information had come from John Dunbar, then in charge of horticulture in the Rochester Parks. A trip was soon arranged, and Mr. Dunbar took me to the town of Leroy, and pointed out a fine colony of this Azalea at the top of one of the largest limestone quarries of the State of New York. On climbing up there, however, we found the shrub to be growing not in limestone at all, but in a bed of silica rock, and the reaction of the soil around its major roots to be subacid. This observation was duly published by Dr. Coville (and more recently by the writer in the National Horticultural Magazine) ; but alas, corrections seem never to catch up with mistakes, and the misunderstanding as to the soil acidity preference of *Rhododendron roseum* is still perpetuated by one horticultural writer after another.

While in no other woody plant family do the bulk of the members prefer acid soils, the following 25 native American species, and some of their relatives, do belong in this category:

Acer pennsylvanicum
Aronia arbutifolia
Betula lenta
Castanea dentata
Ceanothus americanus
Chamaecyparis thyoides
Chionanthus virginica
Comptonia asplenifolia
Cornus florida
Fothergilla Gardeni
Franklinia alatamaha
Gordonia Lasianthus
Halesia tetraptera
Ilex opaca

[1]Dr. Wherry's article "Notes on the Geology and Ecology of the Morris Arboretum," which appeared in Vol. 6, No. 4, pp. 38-42, of this Bulletin, elicited so much interest in the relationships between plants and soils that we have invited him to prepare the present article. Ed.

| | |
|---|---|
| Juniperus horizontalis | Spiraea tomentosa |
| Magnolia virginiana | Stewartia Malacodendron |
| Picea rubens | Styrax americana |
| Pinus rigida | Symplocos tinctoria |
| Quercus rubra | Tsuga canadensis |
| (and other Red Oaks) | Viburnum acerifolium |

Little information is as yet available as to species from foreign countries, but a list can be given of genera of which most species (both native and exotic) seem relatively indifferent to soil reaction, and so can be used in areas shown by indicators to be circumneutral: *Abelia, Acer, Aesculus, Berberis, Buddleia, Buxus, Callicarpa, Celastrus, Clematis, Cotoneaster, Crataegus, Deutzia, Euonymus, Fagus, Forsythia, Fraxinus, Hedera, Hydrangea, Juglans, Juniperus, Ligustrum, Lonicera, Philadelphus, Prunus, Pyrus, Rhamnus, Ribes, Rosa, Spiraea, Syringa, Taxodium, Taxus, Thuja, Ulmus,* and *Wisteria.*

## New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since December, 1956:

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Mrs. Edward Weiss

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Notes on THE GENUS PHLOX, Arboretum Monograph III, by Edgar T. Wherry.

The following misprints have been noted:

p. 14, col. 1, line 12, for 121° read 120°.
p. 62, col. 2, line 1, after tharpii insert (Whitehouse).
p. 64, col. 1, line 15, for 1947 read 1847.
p. 111, col. 2, line 4, for $^{1}$ read $^{3}$.
p. 137, col. 1, line 13, for mm. read cm.
p. 137, col. 1, line 23, for 15:2 read 15:3.
p. 137, col. 1, line 27, for 15:3 read 15:2.
p. 137, col. 2, line 12, for mm. read cm.
p. 146, col. 1, line 22, for 17:1 read 17:2.
p. 146, col. 1, line 26, for 17:2 read 17:1.
p. 164, col. 1, line 3, for Status novus read Comb. nova.
p. 166, col. 1, line 13, for Infor . . . read Inflor. . .
p. 166, col. 2, line 3, for 1934 read 1834.

The staff of the Bailey Hortorium disagreed with my interpretations of certain rules of nomenclature followed in making new combinations. While I do not concur with them, in order to render my namings usable in their new edition of Hortus, those in question have been republished in Baileya 4: 97, 1956.

E. T. W.

# Morris Arboretum Bulletin

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VOL. 8 NUMBER 2



*Actinidia arguta at the Arboretum*

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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# Arboretum Activities

## New Plantings

The late winter and early spring of this year have been a period of considerable activity with respect to the setting out of new groups of plants. In the first place, the area devoted to the display of Glen Dale Azaleas, which were so much admired last May, has been further extended to include an appreciable series of color forms not hitherto exhibited at the Arboretum.

An even more ambitious undertaking has been the conversion of the Oak Row Nursery into an orderly planting of Rhododendrons and Azaleas. This was a rather extensive nursery in which for a number of years we have been testing out these plants prior to selecting the most worthy. The area is now being transformed into a series of beds and walks which, when completed, will have the advantage of continuing our so-called

*(Continued on Page 34)*

# Actinidia at the Morris Arboretum

John M. Fogg, Jr.

The genus *Actinidia* contains about 35 species of deciduous twining shrubs or woody vines with alternate, simple leaves, many-stamened flowers and fleshy fruits. Although most of the species occur in China, the genus as a whole ranges from the Himalayas, Burma and Malaysia to eastern Siberia, Korea, Sakhalin and Japan. Several of the species are greatly valued in Asia because of their edible fruits and some half dozen have found their way into cultivation in this country, chiefly as ornamental vines.

Formerly placed in the Dilleniaceae, *Actinidia* is regarded by most botanists today as belonging, along with *Clematoclethra* and one or two other genera, to a family bearing its own name, the Actinidiaceae. Since the affinities of this family are with the Sterculia Family and the Tea Family which (includes not only Tea but such genera as *Franklinia, Stewartia* and *Camellia),* it is not surprising to find that the flowers of *Actinidia* are characterized by the presence of numerous showy stamens. In fact, it is the large crown of golden or purple stamens which imparts to the otherwise inconspicuous flowers of some species their showy quality.

Several of the Actinidias which are hardy in our area are robust climbers with attractive foliage and deserve to be more widely used for screening purposes or even as hedge plants. The leaves are generally large and heart-shaped and manifest considerable variation with respect to pubescence and color patterns.

The flowers of this genus are for the most part imperfect (unisexual) and the plants are generally dioecious, that is, male and female flowers occur on different individuals. This means, of course, that in order to insure the production of fruit one must have both staminate and carpellate plants, a situation familiar to all who grow hollies and other dioecious genera.

The fruit of *Actinidia* is a berry with greenish pulp and numerous small seeds. Two species in partciular, *A. chinensis* and *A. arguta,* have long been used in China for their edible fruits which have a pleasant acid taste.

Among the species cited by Rehder (1940) as being in cultivation in this country are: *A. chinensis* Planch., *A. callosa* Lindl., *A. melanandra* Franch., *A. Kolomikta* (Maxim. & Rupr.) Maxim., *A. polygama* (Sieb. & Zucc.) Miq., and *A. arguta* (Sieb & Zucc.) Miq. A half dozen others are mentioned as of possible interest to American growers. In 1952 Dr. Hui-Lin Li, Taxonomist of the Staff of the Morris Arboretum, published a comprehensive study of the genus which is recommended to those who desire to achieve a fuller understanding of this fascinating group of plants.

The following species are in cultivation at the Arboretum and the chief purpose of these notes is to call attention to their value as hardy and attractive climbers.

A. CHINENSIS. Chinese Actinidia. Yang-tao.

As indicated by its name, this species is a native of China where it is of widespread occurrence, particularly in the Yangtze valley. It is a vigorous climber, often attaining a height of 25 or 30 feet. The young branchlets and petioles are covered with prominent soft reddish or brownish hairs which give them a somewhat velvety appearance. The large heart-shaped



Fig. 16. *A. chinensis*



Fig. 17. *A. chinensis* at Lankenau Girls' School, Germantown, Philadelphia.

leaves are dark green above and whitish tomentose beneath with reddish to brownish hairs on the veins (See Fig. 16). A characteristic feature of the leaves is their prominently ciliate margins, which results from the prolongation beyond the edge of the leaf of many of the smaller veins.

The flowers of *A. chinensis* appear on the wood of the previous year and the creamy-white to yellowish corollas, about 1½ inches in diameter, are almost obscured by the conspicuous crown of bright yellow stamens. In bloom this is one of the most attractive members of the genus.

The fruit of this species is an ovoid to subglobose berry covered with short brownish hairs. It has long been cultivated in China where it is known as Yang-tao. E. H. Wilson (1913. v. 2, p. 32) states that the plant "produces excellent fruit of a roundish or oval shape, 1 inch to 2½ inches long, with a thin, brown, often hairy skin covering a luscious green flesh." He adds, "In 1900 I had the pleasure of introducing this fruit to the foreign residents of Ichang, with whom it found immediate favour, and is now known throughout the Yangste Valley as the "Ichang Gooseberry." I also was privileged to introduce it into European cultivation and it fruited in England for the first time in 1911."

David Fairchild (1947. p. 203) speaks with appreciation of the "hairy fruits that reminded us of giant English gooseberries." Fairchild (1927) has also described an interesting hybrid which he made between this species and *A. arguta*. This hybrid was later designated as × *A. Fairchildii* by Rehder (1939).

The single plant of *A. chinensis* growing in the Arboretum is a young one, probably not more than five or six years old, and has not yet produced flowers. In the spring its new growing tips are extremely attractive with their covering of reddish velvety pubescence.

A very handsome plant of this species is to be found on the grounds of the Lankenau Girls' School on School Lane in Germantown. Here the plant covers a large arbor and the stems are 4 or 5 inches in diameter at the base. (See Fig. 17)

A. KOLOMIKTA. Kolomikta Vine

A native of China, Manchuria and Japan. In contrast to the foregoing, this species is a rather weak climber with a reported maximum height of 8 to 10 feet. With us it appears more inclined to remain a low sprawling shrub.

The large, thin, heart-shaped leaves (See Fig. 18) are frequently pubescent on the veins, although they lack the whitish tomentum and reddish hairs which characterize *A. chinensis*.



Fig. 18. *A. Kolomikta*



Fig. 19. *A. arguta.* Leaves of male plant.

Several writers have called attention to the rather striking sexual dimorphism which occurs in the foliage of various species of *Actinidia.* This is well seen in *A. Kolomikta,* in which the leaves of the male plants are generally more variegated, with white or pink blotches, than are those of the female. The same apparently holds for *A. polygama.*

The flowers of *A. Kolomikta* are white, about ½ inch in diameter, and somewhat fragrant. They are said to be strictly unisexual and the plants themselves are diocecious. The oblong berries are green or yellow when mature and are reputed to be sweet though insipid. Our material is not yet sufficiently mature to have produced fruit.

*A. Kolomikta* has frequently been confused with the Silver Vine, *A. polygama.* However, as pointed out by Bailey, Rehder and others, the pith of *A. Kolomikta* is lamellated (chambered) and brownish in color, whereas that of *A. polygama* is solid and white.

A. ARGUTA. Bower Actinidia. Japanese Kokuwa.

A wide-ranging species which occurs from eastern Siberia, Manchuria and northern China to Korea and Japan. This is one of the most vigorous of all members of the group; in the native state it is said to climb to the top of tall trees (Bean. 1940, p. 30) and relatively young plants at the Arboretum have produced an amazingly dense growth on a cyclone fence around the farm nursery (See cover).

The leaf-blades of this plant have the same general size and shape as those of *A. Kolomikta,* but are abruptly acuminate at the apex (See Fig. 19), and the lustrous green leaf-surfaces contrast strikingly with the bright red color of the petioles. Here, again, there is frequently a pronounced difference between the leaves of the male and female plants.

The whitish corollas of this species are slightly tinged with green and the numerous stamens are purplish, whereas those of the two preceding species are yellow or orange. *A. arguta* is strictly dioecious and in the picture shown on the cover the plant on the left is male while that on the right is female.

The smooth oblong fruit of *A. arguta* is about one inch in length (See Fig. 20), greenish-purple when mature and rather pleasantly sweet. Our carpellate plant fruited copiously in the autumn of 1956 and the members of the staff who sampled them likened them to figs. Fairchild (1947. p. 203) records a similar impression and Wyman (1949. p. 367) states that preserves have been made from the fruit.



Fig. 20. *A. arguta.* Leaves and fruit of female plant.

The three Actinidias described above are interesting subjects and should be more widely grown. The vigorous habit of *A. chinensis* and *A. arguta* recommends them for any situation where a quick dense screen is desired. They lend themselves well to growing on a fence, an arbor, a bank or an unsightly stone pile. The flowers of all, while not spectacular, are interesting and attractive, and the fruits, as already indicated, are not without merit.

It is hoped that several other species which are known to be hardy, such as *A. polygama, A. rubricaulis* and *A. melanandra,* will soon be added to our collection so that visitors may have an opportunity of becoming acquainted with them.

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# The Origin and History of the Cultivated Plane-trees


Hui-Lin Li



*(Continued from Page 9)*


## Origin of the London Plane

The London Plane apparently first appeared in cultivation in the 17th century. Various opinions were expressed regarding its origin and there were attempts to trace it to some Asiatic sources. While it was first generally regarded as a variety of the Oriental Plane, from the very beginning suggestions of its hybrid nature appeared from time to time in the literature.

Henry made a thorough study of this problem (1908). At first he rejected the hybrid origin of *P.* × *acerifolia,* but his subsequent investigations (1919) led him to believe firmly in the hybrid origin of the London Plane. Such is the view now generally accepted. Henry is of the opinion that the remarkable vigor of the London Plane, its power of resistance to drought, smoke and other unfavorable conditions of soil and atmosphere, is due to its hybrid origin.

Henry believes that the London Plane must have originated as a chance seedling in some botanic garden, where an American Plane and an Oriental Plane happened to grow close together. His historical research led him to surmise it was possibly originated in the Oxford Botanic Garden at about 1670.

Henry's surmise was based on the following: The American Plane was introduced from America to England by Tradescant in 1636, while the Oriental Plane arrived about a century earlier. By 1670, the American species would be old enough to bear pollen. There is a manuscript left by Jacob Bobart, Jr., curator of the Botanic Garden at Oxford in 1680, which is without date, although a similar one bears the date 1666. In the enumeration of Planes in cultivation, besides *P. orientalis* and *P. occidentalis,* a plant is listed as "P. inter orientalem et occidentalem media", and corresponding to this diagnosis of a "Plane intermediate between the Oriental and American species", there is a herbarium specimen, undoubtedly *P.* × *acerifolia,* in the Sherard Herbarium at Oxford, labeled "Platanus media". Specimens labeled "Platanus media, n.d. Bobart, Ox." are in the British Museum, made at about the same period, together with the type specimen of the first published description of the London Plane by Plukenet in 1700.

Thus, it is the opinion of Henry that the original tree which Plukenet describes as bearing large fruit balls in 1700, was then living in the Oxford Botanic Garden, and as it may have been then thirty years old, this would give the date of origin of *P.* × *acerifolia* as 1670.

Henry's surmise, which as he says is something which cannot be definitely proved, may not be far from the truth. It gives, however, only the earliest historic records of the tree, and does not necessarily mean that subsequent trees of the London Plane are all derived from this single individual, as implied by Henry.

Henry, moreover, points out earlier (1908) that the *P. occidentalis* of Evelyn's Sylva, ed Hunter 1683, is undoubtedly *P.* × *acerifolia.* This shows that there might possibly be more than a single source of origin even at this early date.

A point against Henry's assertion that *P.* × *acerifolia* originated in England is the fact that *P. occidentalis* does not live long enough to flower in England and that there is no record that

the tree ever flowered there in former times (Bean 1919). Although the earliest record of *P.* × *acerifolia* is from English sources, nevertheless, it is quite possible that actually it might have originated concurrently or exclusively on the European continent where both *P. occidentalis* and *P. orientalis* are hardy.

The first record of the London Plane on the continent was made by Tournefort in 1703 as "P. orientalis aceris folio". Since then the cultivation of this tree has spread all over the continent.

An early opinion on the origin of this plant was expressed by Miller (1731) who says of *P.* × *acerifolia,* "Although by some supposed to be a distinct species from either *P. orientalis* or *P. occidentalis,* it is no more than a seminal variety of the first; for I have had many plants that come up from seeds of the first sort which ripened in the Physick Garden (Chelsa), which do most of them degenerate to this third sort; which, in the manner of its leaves, seems to be different from either, and might reasonably be supposed a distinct kind by those who have not traced its original".

The current scientific name of the plant is adopted from the one given by Aiton in 1789, who considers it as a variety of the Oriental Plane as *P. orientalis acerifolia* (in Hort. Kew. 3: 304. 1789). Willdenow is the first to accord it specific status as *P. acerifolia* (Ait.) Willdenow (in Linn. Sp. Pl. ed. 4, 1: 474. 1805), but, in spite of this, most authors, up to the beginning of the current century, treated it as a variety of *P. orientalis.*

The London Plane is a tall tree with an upright stem, attaining to a size intermediate between the taller *P. occidentalis* and the slightly lower *P. orientalis.* The bark usually exfoliates in large flakes as in *P. orientalis* and the inner bark is variable in color. The leaves are large, with fine broad triangular lobes resembling more closely those of *P. occidentalis* but in general the middle lobe is slightly narrower. The lobe is about as long as broad while in *P. occidentalis,* the middle lobe is broader than long. The fruiting heads are extremely variable in size and number on the peduncle; mostly in twos, but varying to as many as six. The individual achenes are similar in structure to those of *P. orientalis* and do not resemble those of *P. occidentalis.*

It can thus be seen that *P.* × *acerifolia* resembles *P. occidentalis* more closely in foliage characters and *P. orientalis* in fruiting structures. Because of the close similarity of the leaves between *P. occidentalis* and *P. orientalis,* the two were much confused with each other in the literature of the 18th and 19th centuries. Inasmuch as *P. occidentalis* is quite unsuitable to the climate in England and Europe, it must have been very rare in these countries in former times (as at the present) and plants referred to as *P. occidentalis* were actually invariably *P.* × *acerifolia.* Not until 1856 did Hooker (1856) clarify the confusion by distinguishing the two on the basis of fruiting characters, which had hitherto been unnoticed.

The hybrid nature of the plant, although not definitely recognized at first, was long suspected by many authors. A horticultural name, *P. intermedia* Hort., of unknown origin but expressing the apparent hybrid nature of the plant, long appeared in the synonymy of *P.* × *acerifolia.* It is listed under *P. orientalis* var. *acerifolia* Ait. by Loudon in 1844,[4] and might have been in existence much earlier.

That the hybridization did not occur in one instance only is indicated by the independent recognition of this phenomenon in several other countries. Before 1731, there was known in England a plant called the Spanish Plane-tree which is essentially similar to *P.* × *acerifolia* but with wider leaves having more cordate bases. The tree, described in Miller's Dictionary, ed. 7, published in 1759, is based on one he planted in 1731 as a variety accidently arisen from seed. His description is unmistakably that of the Spanish Plane later known as *P. hispanica.* This rare tree, which originated some time before 1731, was, in the opinion of Henry, probably a seedling of one of the early London Planes. The same tree was imported to England from France in 1856 under the name *P. macrophylla* (Rivers 1860).

In 1804, Brotero, Fl. Lusitan. 2: 487. 1804, describes *P. hybridus* from plants cultivated in Portugal. Although this is generally but doubtfully referred to the synonymy of *P. occidentalis,* there is a strong indication that it should be considered as a synonym of *P.* × *acerifolia,* which has actually a year's priority over the latter name.

These various records seem to indicate that hybrids between *P. occidentalis* and *P. orientalis* appear to have arisen independently in several different countries at different times. It may be argued that the Portuguese and Spanish plants were introduced from England, but inasmuch as they are quite distinct from the English types, this seems rather unlikely. On the contrary, the Spanish plant, which was called Spanish Plane in England as early as 1759 or earlier, must have come from Spain rather than the reverse. Furthermore, *P. occidentalis* is known to be tender in England, seldom reaching the adult fruiting

[4] This antedates Rehder's assertion (Rehder 1949) that the name, in synonymy, is to be credited to the Kew Handlist of Trees and Shrubs of 1896. Still less understandable is the listing of this name by Index Kewensis Suppl. 9, 1938, attributing this name, also in synonymy, to Chow, Familiar Trees of Hopei, 1934. This latter work follows essentially the nomenclature as given in the first edition of Rehder's Manual of 1927.

stage there, but is more at home in southern Europe. In the latter area hybrids between it and *P. orientalis,* which is also more commonly planted there than in England, are more likely to occur than in any region further north.

The Spanish Plane, also known as *P. macrophylla* as illustrated and described by Bean (1919) from trees grown in England, shows more distinctly the influence of *P. occidentalis* in its fruiting characters than other plants of *P.* × *acerifolia.* The fruiting heads, occasionally 2 or 3 together, are frequently solitary, with the individual achenes almost smooth and more flattened at the apex than those of *P. orientalis.*

### Variations of the London Plane

From the records, it seems therefore justifiable to conclude that *P.* × *acerifolia* or the London Plane is an assorted group of trees of variable characters which have originated as hybrids between *P. orientalis* and *P. occidentalis* independently in different countries in eastern Europe and the British Isles at various times. Since the two species hybridize, it is very unlikely that hybridization happened only once and not in other localities, especially where more individual trees of both species are present. The two parent species concerned are very variable in their characters. This explains the occurrence of the many different types of hybrid progenies derived from these two species. These progenies, whether propagated vegetatively or as seedlings, maintain or further increase the variation of the complex known collectively as *P.* × *acerifolia.*

Among the cultivated specimens of *P. orientalis* in Europe, there are usually recognized two varieties, *cuneata* and *digitata.* Although their leaves resemble more closely *P. orientalis,* Henry is apparently right, in view of their frequently imperfect achenes, in considering them as of hybrid origin. Henry believes them to be second generation seedlings of *P.* × *acerifolia.* Although we have no way of ascertaining their origins, they are possibly cultivated clones of advanced generation segregates of the hybrid *P.* × *acerifolia* that resemble most closely *P. orientalis* in leaf shape.

Henry (1919) recognizes *P.* × *acerifolia* as the first generation hybrid of *P. orientalis* and *P. occidentalis* and accepts six additional "species" as second generation hybrids, including *cuneata* and *digitata,* mentioned above, and two new species of his own as follows:

*P. hispanica* Muenchhausen
*P. pyramidalis* Rivers
*P. cuneata* Willdenow
*P. digitata* Gordon
*P. cantabrigiensis* Henry
*P. parviloba* Henry

According to modern taxonomic concepts and nomenclatural practices, since *P.* × *acerifolia* is considered as a hybrid between *P. orientalis* and *P. occidentalis,* it should be designated either by the formula *P. orientalis* × *occidentalis* or by the name *P.* × *acerifolia.* Only one specific epithet is admissible in this case, and such other specific names as given by Henry, if considered as of hybrid origin between the two same parental species, should all be included in this concept. Variations within *P.* × *acerifolia* should be recognized as cultivars (cv.) and rendered in Roman in quotes instead of using italicized Latin names. Such cultivars as are propagated solely by vegetative means from a single known stock are known as clones (cl.). The recognized variations of *P.* × *acerifolia* (Henry & Flood 1919, Rehder 1940) are described and discussed below.

(1) *P.* × *acerifolia* cv. 'hispanica'

Leaves large, often 30 cm. in width, persistently tomentose on the nerves and petioles, shallowly cordate or cuneate at base, with 5 distinct short, broadly triangular lobes, the margins dentate. Heads not so flattened as in *P. occidentalis* and not so conical as in *P. orientalis.*

This taxon appeared formerly also under the names, *P.* × *acerifolia* var. *hispanica, P. hispanica,* or *P. macrophylla.* It is cultivated in England and France, but is apparently unknown in America. It is a vigorous tree, which, according to Henry, produces good seeds from which seedlings, which are not uniform, can be easily raised; however, in nurseries it is invariably propagated by cuttings.

(2) *P.* × *acerifolia* cv. 'cuneata'

Small tree. Leaves deeply 5-lobed, very cuneate at base, conspicuously dentate at the margins, practically glabrous when adult. Fruiting heads 2-4, small, rarely over 2 cm. in diameter, composed of few, often imperfect achenes.

This is a variety long placed in *P. orientalis,* as young trees of cultivated *P. orientalis* and even certain adult wild forms often bear cuneate leaves and are scarcely distinguishable. But Henry points out that this variation is distinguished by its fruiting heads, which are small and often made up of few mostly imperfect achenes and for this reason he believes it to be probably of hybrid origin. It conceivably originated sometime before 1789, when it was first made known by Aiton.

(3) *P.* × *acerifolia* cl. 'digitata'

Leaves resembling *P. orientalis* but much smaller, to 13 cm. broad, the base truncate but with a short central cuneate part, the lobes 5, elongated, dentate, with wide sinuses. Fruiting heads 2-3, very small, about 1.2 cm. in diameter,

composed of a few imperfect achenes.

Henry is probably right in suggesting this as originated from a seedling of *P.* × *acerifolia,* and not a variety of *P. orientalis,* as designated by most authors. According to him, it is rare in cultivation, and only two trees are known, both in England.

(4) *P.* × *acerifolia* cl. 'pyramidalis'

Of upright habit, the lower branches widespread but not drooping when old. Leaves truncate, usually 3-lobed, the lobes broadly triangular, slightly dentate.

This clone was probably originated in France about 1850. It is now much planted in England as a street tree.

(5) *P.* × *acerifolia* cl. 'Kelseyana'

Leaves spotted in the center with yellow, the margins green. Known also as *P.* × *acerifolia* var. *aureo-variegata.*

(6) *P.* × *acerifolia* cl. 'Suttneri'

Leaves large, white over most of the surface but with green spots in the center.

(7) *P.* × *acerifolia* cl. 'cantabrigiensis'

Leaves rather small, to 13 cm. wide, the base truncate with a cuneate central part, 5-lobed, the lobes distinct, short, triangular, entire or with 1 or 2 teeth. Fruiting heads 3, small, about 2 cm. across, of few imperfect achenes.

A single tree of unknown origin in the Cambridge Botanic Garden, described by Henry as *P. cantabrigiensis.*

(8) *P.* × *acerifolia* cl. 'parviloba'

Leaves variable, truncate to cuneate, with 3 triangular or oblong-triangular slightly dentate or entire lobes and 2 additional small lobes or teeth near the base. Fruiting heads 3-6, small, about 2 cm. across, made up of a few achenes, some imperfect.

A single grafted tree at Kew of unknown origin; described by Henry as *P. parviloba.*

## The London Plane in America

The London Plane, as well as the Oriental Plane, must have been introduced into America from Europe during colonial times, although records of its early introduction do not seem to exist. As mentioned above, the London Plane and the Oriental Plane were often not distinguished in the horticultural literature of the 19th century and earlier, and what was mentioned as the Oriental Plane was in all cases the London Plane. The confusion between the two seems to persist up to the present, especially in the trade, while in Europe, the London Plane was formerly much confused with the American Plane.

In Philadelphia, there is a generally circulated notion that William Harper, who presumably raising them from seed, first introduced the London Plane into this country about fifty years ago. A published record of this is found in R. H. True's report of Jackson's lecture on the diseases of the Plane-tree in 1936 (True 1936), "It was reported by Mr. S. N. Baxter, City Arboriculturist of Philadelphia, in the discussion following the lecture, that this type of Plane tree [London Plane] was introduced into Philadelphia about thirty years ago by Mr. William Warner Harper, of Andorra Nurseries." Mr. Harper is apparently the first one who introduced this tree on a large scale, but earlier than this the London Plane must already have been in existence in this country, especially around Philadelphia, as there are references to it, for instance, in Meehan's Monthly in the late nineteenth century. The tree was then usually known as the "Oriental Plane." Incidentally, at Andorra Nurseries, the London Plane is today still called"Oriental Plane" and since they propagate it solely by cuttings, their present nursery stock may be the direct descendants of the early trees introduced by Harper from London some fifty years ago.

In North America, the Oriental Plane is not hardy in the north, but the London Plane is hardy as far north as southern New Hampshire. As noted above, the true Oriental Plane occurs rarely if at all in cultivation anywhere in North America, and trees bearing this name are nearly all referable to the London Plane. Actually nearly all the Plane-trees extensively planted along the streets throughout the country are London Plane, as the native American Plane, because of its susceptibility to fungus disease, is not satisfactory for this purpose.

The London Plane, as cultivated in this country, appears to be extremely variable. In and around Philadelphia, observations made on numerous trees in parks and along streets show that marked variations are readily discernible in the color of bark, shape of leaves and number and size of fruiting heads. The inner bark varies in color from brownish to silvery grayish and the outer bark peals off in patches of different sizes and in different degrees, although more often it peels off in relatively larger patches. The leaves are exceedingly variable in size and shape, including the base, the number, size and shape of lobes, the serrations, and the hairiness. The fruiting heads are mostly in twos, but the number varies from one to three and occasionally more.

The general shape of the leaves of the London Plane in America, however, seems to differ from those in Europe, especially in older trees. The lobes of the American trees are broad and short, and while they are slightly longer than those of the American Plane, *P. occidentalis,* they are much shorter and broader than those of *P. orientalis.* The sinuses are broad and shallow. (Fig. 5) In the older trees in Europe, for instance, the London Plane tree near the Rue Jussieu en-

trance of the Jardin des Plantes, Paris, and a tree at Kew, the leaves are deeply and narrowly lobed, approaching very closely the condition in *P. orientalis*. The Paris tree bears the label "Platanus × acerifolia, orientalis × occidentalis, connu depuis 1670. Un des 3 pieds plantés par Buffon entre 1784 et 1788". These trees bear leaves resembling very closely the few supposed specimens of *P. orientalis* of Philadelphia and New York and for this reason it is suggested that these American trees may also be segregates of hybrids between *P. orientalis* and *P. occidentalis*. Like the other London Planes they happen to be extremes more closely resembling one of the two parents and are not true or pure *P. orientalis*.

It is, however, entirely clear that the London Planes now planted in America are significantly different from the London Plane-trees in Europe, especially those planted one or two hundred years ago. The trees in Europe show strong affiliation with *P. orientalis,* as manifested particularly in the shape of the leaves. The plants generally grown in America show more closely and strongly characters of *P. occidentalis*. While a more definite solution to this problem requires detailed analysis of specimens in quantities, our observation so far points out that most of the London Planes in America are probably not first generation hybrids of *P. orientalis* and *P. occidentalis,* but are raised from hybrids of these species, back-crossed, perhaps successively for more than one generation, to the native American *P. occidentalis*.

The importance of London Plane to modern cities can hardly be over-emphasized. As mentioned before, out of 158,000 trees planted along the sidewalks of Philadelphia, nearly one-third are London Plane. In New York City, 2,282,000 trees are under the care of the Park Department, a large proportion being London Planes, especially in Manhattan, where the London Plane, numbering 47,000, forms the bulk of the tree population. (New York Times, Aug. 26, 1955)

London Plane originated and spread under man's tutelage less than three hundred years ago. Its dramatic use by man parallels the rapid development and expansion of modern cities, including New York and Philadelphia, within the same age. The mutual dependence of London Plane and modern city dwellers constitutes an important and interesting chapter in anthropological chronicles. Many modern urbanites are not aware of the fact that as their forefathers removed the natural vegetation of the land to create cities, it was largely the London Plane that took the place of forest trees. These trees of the city streets not only shade their abodes and beautify their surroundings but also remind them of the changing seasons of the year and purify the very air they breathe.

## Common Names of Plane-trees

Confusion in the status of cultivated Plane-trees can be attributed in part to the numerous common names applied or misapplied to these plants, which in turn, reflect their variable nature and puzzling origins.

The name "Plane" derives from the scientific name *Platanus* adopted from the classical name derived from the Greek *platys,* meaning ample, in allusion, according to most authors, to its spreading branches and shady foliage. Fernald (1950), however, says that *platys, broad,* apparently refers to the large leaves. It is known as Platanus in German and Platane in French. In America, the common name of the different Plane-trees is Sycamore but in Europe this name is always applied to *Acer pseudo-platanus* and never to the Plane. In Scotland the name Plane-tree is also applied to *Acer pseudo-platanus*. Actually Sycomorous of the ancients is the *Ficus Sycomorous* of northeastern Africa.

Oriental Plane is the name generally applied to *P. orientalis* in England and America, although in the literature it is occasionally also known as Eastern Plane. It is called Morgenlandischer Platanus in German and Platane de l'Orient in French and is known to the Persians as Chinar and to the Arabs as Doolb. (Loudon, 1844)

The American Plane, *P. occidentalis*, is also known in the horticultural literature of England as the Occidental Plane or the Western Plane. In America, besides being called Sycamore, it is commonly known also as Buttonwood, and sometimes by such less common names as Cotton Tree, Water Beech or Button-ball Tree.

The London Plane and its variations have acquired a long list of names in less than 300 years since their first appearance. In the literature, the following names, most of them no longer in use, are recorded: Park Plane, Spanish Plane, London Plane, Sycamore, Maple-leaved Plane, European Plane, Oriental Plane and Eastern Plane. The last two names were applied to the London Plane in earlier literature, when it was generally considered as a variety of *P. orientalis*, and this indiscriminate use, as mentioned before, is a main source of confusion of the two Plane-trees in subsequent years, in both the trade and in horticultural literature, down to the present.

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# Trees and Soil Reaction

Edgar T. Wherry

Pennsylvania-German naturalists have a tradition that their ancestors, on coming to this country and being given a choice of areas to occupy, passed up those forested chiefly by oak and pine and selected those where such trees as elm, linden, and walnut were prominent. Experience in their native land had shown them that trees of these genera were indicators of especially desirable agricultural soils; and so it turned out. They occupied and cultivated with marked success the strip of limestone land curving across the southeast corner of this state from the present Northampton to York counties. Soils derived from limestone are relatively high in nutrient elements and circumneutral in reaction, whereas those formed from shale, sandstone, granite, etc., tend to be lower in nutrients and more or less acid. These contrasted sorts of soils favor the growth of dissimilar groups of trees.

### Conifers

For the most part our coniferous trees thrive best in the more acid, nutrient-poor soils, although (as usual) there are a few notable exceptions. American Arbor-vitae or Northern White Cedar *(Thuja occidentalis)* flourishes in the limy swamps of Canada and the northern United States, and attains great age and size on the limestone of the Shenandoah Valley, notably around Natural Bridge, Virginia. Red Cedar *(Juniperus virginiana)* reaches its maximum development in the limestone glades of Tennessee, while in land underlain by dominantly siliceous rocks it tends to occupy spots where local conditions keep the acidity down. Yellow or Shortleaf Pine *(Pinus echinata)* and Virginia or Scrub Pine *(P. virginiana)* are lime-tolerant, and are conspicuous in the above-noted Shenandoah Valley. Hemlock *(Tsuga canadensis)* while most frequent on decidedly acid soils, can occasionally grow on limestone cliffs if these are especially steep and bleak.

### Catkin-bearers (Amentiferae)

Members of two families in this group, — elms and walnuts — were mentioned in the opening paragraph as indicators of nutrient-rich soils. Most of their relatives, like hickories and mulberries, also thrive in such situations. In contrast, the majority of the members of the Birch and Oak Families are better adapted to acid, nutrient-poor soils. They flourish over sandstone and granite, and manage to survive on limestone only where this outcrops on steep, dry, slopes. Again there are exceptions: Shingle Oak *(Quercus imbricaria)*, Overcup Oak *(Q. macrocarpa)* and Yellow Oak *(Q. Muhlenbergii)* are, in regions of moist climate, limestone indicators, while White Oak *(Q. alba)*, and Post Oak *(Q. stellata)* are de-

cidedly lime-tolerant, and able to grow well in both acid and circumneutral soils.

### A Dozen More Tree-including Families

Among the Magnolias, only one native, Sweet Bay *(M. virginiana)* requires strongly acid soil. Sassafras, Sweet-gum, and Sycamore do best in loamy soil where the acidity is moderate but nutrients are abundantly available. Many of the members of the Rose Family thrive on limy, nutrient-rich soil; American Mountain-ash *(Sorbus americana)* is an exception, requiring acidity. The root-nodule bacteria which help nourish trees of the Legume Family are favored by circumneutral reactions, although the Black Locust *(Robinia pseudo-acacia)* is tolerant of high acidity. Our prickly Holly *(Ilex opaca)* favors mild acidity, and is poisoned by abundant lime. Ash-leaved Maple *(Acer Negundo),* Silver Maple *(A. saccharinum)* and Sugar Maple *(A. saccharum)* are plants of nutrient-rich soils, while Red Maple *(A. rubrum)* shows as wide a range of tolerance as any of our trees. Linden *(Tilia americana)* favors mineral-rich soils, while White Ash *(Fraxinus americana)* seems indifferent to soil chemistry. Sour Gum *(Nyssa sylvatica)* and White Dogwood *(Cornus florida)* belong to the moderately acid group, and rarely thrive on limestone.

### The Michaux Quercetum

Several years ago the American Philosophical Society sponsored the assembling of a living collection of oaks, in honor of the pioneer worker on these trees in America, Francois André Michaux. Under the auspices of the Morris Arboretum, acorns of numerous species from many parts of this country, and some from abroad, were sent in by foresters, botanists and naturalists, accompanied by full authenticating data. These were duly planted, grown for a couple of years, and their species identity checked.

When the time came to set these out, however, a problem arose. As shown on the map published in the first of my essays on soil reaction in this Bulletin,[1] the northern third of the tract is underlain by limestone; and as its surface is relatively flat, mineral-rich, circumneutral soils have accumulated there. Here was the only space available for planting oaks; yet only one fourth of the species, at most, could be expected to reach maturity there.

To quote Lutz:[2] "From time to time, foresters have attempted to develop artificial associations of trees which have no known counterpart in nature. Trees have been moved outside their natural ranges and habitats and confronted with environmental conditions . . . that they have never previously experienced in their evolutionary development. Many, if not most, of these attempts have led to unhappy results. Diseases, arising from both insects and fungi, appear to be more prevalent in artificial associations than in natural ones, and their damage is often more serious."

In the present case, while seedlings of the oaks obtained were planted out on the limestone plateau, three fourths of them can be expected to become chlorotic and to fall prey to diseases in a relatively few years. Fortunately for the project, the Longwood Foundation came to the rescue. Their land, largely subacid, low-nutrient loam over schistose rocks, is well suited to the growth of the majority of our oaks. So it is there that future botanists can observe the development of the real Michaux Quercetum.

[1]Vol. 6. 38. 1956.
[2]Ecology, vol. 38, p. 47, 1957.

# New Chromosome Counts in *Acer* and *Fraxinus*

Jonathan W. Wright[1]

The basic chromosome numbers in *Acer* (x = 13) and *Fraxinus* (x = 23) are known from studies made by previous workers.[2] However, there are many species in these genera for which counts have not yet been made.

Counts for several of these species are here reported for the first time. They were made from tissues that were fixed in acetic-alcohol, stained in acetic-orcein, and made into temporary smear preparations according to the recommendations of La Cour.[3] The haploid counts were made from pollen mother cells. The diploid counts were made from leaf smears (older trees) or root tips (seedlings). The material was collected from old trees in the Morris Arboretum and in the Haverford College Arboretum, Haverford, Pa., and from seedlings raised in the Morris Arboretum greenhouse.[4]

The chromosomes in these genera are small — 1 to 3 microns long in *Fraxinus,* and 2 to 5 microns long in *Acer*. For that reason the making of karyograms was not attempted. The counts made are as follows:

### Acer

*A. Buergerianum* Miq. Trident maple. Tree M-1676.[5] n = 13.

*A. cappadocicum* Gleditsch. Coliseum maple. Tree M-1649. 2n = 26.

*A. Henryi* Pax. Tree M-1373. n = 13.

*A. macrophyllum* Pursh. Oregon maple. Seedling NEG-496[5] of Vancouver, B. C. provenance. 2n = 26.

*A. Mayrii* Schwerin. Tree M-57-139. 2n = 26.

*A. Negundo* L. Box-elder. Tree M-57-140. n = 13. (Confirmation of previous count.)

*A. platanoides L.* Norway maple. Tree M-57-141. 2n =-26. (Previously reported as 2n = 26, 2n = 39.)

These chromosome counts bring the number of maple species for which the chromosome number is known to 29. Of these, 24 are diploid, with 2n = 26 chromosomes: *A. argutum* Maxim., *A. Buergerianum* Miq., *A. campestre* L., *A. cappadocicum* Gleditsch, *A. circinatum* Pursh., *A. cissifolium* K. Koch, *A. crataegifolium* Sieb. and Zucc., *A. diabolicum* K. Koch, *A. ginnala* Maxim., *A. griseum* Pax, *A. Henryi* Pax, *A. japonicum* Thunb., *A. macrophyllum* Pursh., *A. manshuricum* Maxim., *A. Mayrii* Schwerin, *A. Miyabei* Maxim., *A. mono* Maxim., *A. Negundo* L., *A. nikoense* Maxim., *A. palmatum* Thunb., *A. pseudosieboldianum* Komar., *A. rufinerve* Sieb. and Zucc., *A. saccharum* Marsh., and *A. tschonoskii* Maxim.

The remaining species are diploid or triploid (*A. platanoides* L. 2n = 26 or 39); tetraploid (*A. carpinifolium* Sieb. and Zucc., *A. pseudoplatanus* L., and *A. saccharinum* L. 2n = 52); or hexaploid and octoploid (*A. rubrum* L. 2n = 78, 104). The five polyploid species are more widespread and aggressive than is the average maple species.

### Fraxinus

*F. americana* L. White ash. Counts of 2n = 46 were made on seedlings of the following provenances: Montgomery County, Penna. (NEG-393); Berkshire County, Mass. (NEG-400); Decatur County, Ind. (NEG-788); Marion County, Ind. (NEG-789, -797); Ripley County, Ind. (NEG-799); and Anderson County, Tenn. (NEG-811). Counts of 2n = approximately 92 were made for seedlings of the following provenances; Montgomery County, Penna. (NEG-391, -392); Pope County, Ark. (NEG-773); and Decatur County, Ind. (NEG-785). (Previous counts of 2n = 46, 92, and 138 were reported for this species.)

*F. anomala* S. Wats. Single-leaf ash. Seedling NEG-387 of Delta County, Colo. provenance. 2n = 46.

*F. Bungeana* D. C. Tree G-1314.[5] n = 23. (Confirmation of previous count.)

*F. chinensis* Roxb. Chinese ash. Seedling of tree M-57-142. 2n = 92. (Previously reported as 2n = 138.)

*F. latifolia* Benth. (= *F. oregona* Nutt.) Oregon ash. Counts were made on seedlings of the following provenances: Washington County, Ore. (NEG-388) and Mendocino County, California (NEG-494). 2n = 46. (Confirmation of previous count.)

[1]Geneticist, Northeastern Forest Experiment Station, Upper Darby, Pa. The author is stationed at the Morris Arboretum, where the observations recorded in this paper were made, in cooperation with the University of Pennsylvania.

[2]Previous chromosome counts in these and other genera are to be found in Darlington, C. P. and Wylie, A. P. Chromosome atlas of flowering plants. 519 pp. Allen and Unwin, London. 1955.

[3]La Cour, L. F. Improvements in plant cytological technique II. Bot. Rev. 13: 216-240. 1947.

[4]Seed was sent in by G. S. Allen, S. B. Chase, F. E. Cunningham, J. W. Duffield, R. C. Friesner, P. H. Gerrard, A. G. Johnson, T. T. Munger, P. A. Munz, R. Nordine, J. F. Potzger, C. R. Towne, and by members of the staff of the Government Forest Experiment Station of Japan. Grateful acknowledgment is made to these collectors.

[5]M—numbers refer to numbers assigned by the Morris Arboretum. G— and NEG— numbers refer to numbers assigned by the Northeastern Forest Experiment Sattion.

*F. longicuspis* Sieb. and Zucc. Seedling NEG-915 of Nagano Prefecture, Japan provenance. 2n = 46.

*F. nigra* Marsh. Black ash. Tree G-1864. 2n = 46.

*F. Ornus* L. Flowering ash. Seedling of tree G-1882. 2n = 46. Confirmation of previous count.)

*F. pubinervis* Bl. Seedling NEG-912 of Akita Prefecture, Japan provenance. 2n = 46.

*F. Spaethiana* Lingelsh. Seedling NEG-913 of Akita Prefecture, Japan provenance. 2n = 46.

*F. tomentosa* Michx. f. Pumpkin ash. Seedling NEG-885 of Morton Arboretum, Chicago, Ill. specimen. 2n = approximately 138.

*F. velutina* Torr. Arizona ash. Counts were made on seedlings of the following provenances: Yavapai County, Ariz. (NEG-532, -533, -534, -535). 2n = 46. (Confirmation of previous counts.)

*F. velutina* var. *coriacea* (S. Wats.) Rehd. Seedling NEG-846 of Rancho Santa Ana Botanic Garden, Anaheim, Calif. specimen. 2n = 46. (Previously reported as 2n = 92.)

The chromosome numbers are now known for 20 species of *Fraxinus*. Of these, 16 are diploid, with 2n = 46 chromosomes: *F. angustifolia* Vahl., *F. anomala* S. Wats., *F. Berlandieriana* D. C., *F. Bungeana* D. C., *F. excelsior* L., *F. floribunda* Wall., *F. Griffithii* C. B. Clarke, *F. holotricha* Koehne, *F. latifolia* Benth., *F. longicuspis* Sieb. and Zucc., *F. nigra* Marsh., *F. Ornus* L., *F. pennsylvanica* Marsh., *F. pubinervis* Bl., *F. sogdiana* Bge., and *F. Spaethiana* Lingelsh.)

The remaining four species (*F. americana* L., 2n = 46, 92, and 138, *F. chinensis* Roxb., 2n = 92 and 138; *F. tomentosa* Michx. f., 2n = 138; *F. velutina* Torr., 2n = 46, 92) are polyploid or diploid and polyploid. The polyploid species or races are widely distributed geographically, and are more closely related to some diploid species or races than to each other. This indicates that polyploidy has been a secondary factor in the evolution of the genus.

# Arboretum Activities

*(Continued from Page 22)*

Azalea Meadow — on the slope below the Gates Building — southward under the shadow of Oak Row and swinging it around so that it joins the plantings of Glen Dales referred to above. Eventually it is our intention to have this entire south-facing slope, with its several acres of open lawn, almost completely bordered with massed plantings of Rhododendrons and Azaleas, backed up by a foundation of *Leucothoe, Pieris* and conifers.

New plantings on the farm area, as previously mentioned in these notes, are being established in accordance with carefully prepared plans. During the fall and winter some 300 trees and shrubs have been set out, not including the oaks in the Michaux Quercetum, which was described in a recent issue.

In a low, moist area to the west of the entrance to this tract we are creating a swamp planting, using Swamp Cypress *(Taxodium distichum)* as a foundation, supplemented by such moisture-tolerant genera as elms, alders, willows, etc. The cypresses are already in place and other plants are being added as they become available.

In the drier sections which have been reserved for some of the large and important families considerable progress is being made and among the groups of which an appreciable representation may now be seen are: Rosaceae, Leguminosae, Aceraceae, Oleaceae, Styracaceae, and Caprifoliaceae.

### Dr. Crane's Lecture

On Tuesday afternoon, March 12, a large group of our Associates and their friends attended a lecture by Dr. Eva Crane which was held in the Mansion. Dr. Crane, who is Director of the Bee Research Association of England, is on a tour of the important bee centers in this country, Cuba and Mexico. The title of her lecture was "From Cottage to Castle: Some Pictures of English Gardens."

In the evening Dr. Crane addressed a group of bee keepers, speaking on "Recent Advances in Bee Research." This session was presided over by Mr. Fred W. Schwoebel, Curator of the Arboretum's Langstroth Bee Garden.

### Recreation Area

Again we call attention to the availability of our Recreation Area for organizations which desire to hold outings there. Although primarily reserved for groups from the campus, these grounds may be used by other organizations, who are asked to make appointments by calling the Office of the Dean of Men in Logan Hall, 36th and Woodland Avenue.

J. M. F., Jr.

## LIBRARY ACCESSIONS

The following volumes have been added to the Arboretum Library during the past year:

*Herbals*, Agnes Arber (Cambridge Univ. Press, 1953)

*China, Mother of Gardens*, Ernest Henry Wilson (Stratford Co., Boston, 1929)

**Der Steinga Ten Und Feine Welt*, Wilhelm Schacht (Stuttgart, 1953)

**Blumenzwiebeln Fur Garten Und Heim*, Wilhelm Schacht (Stuttgart, 1955)

*Azaleas and Camellias*, Harold H. Hume (MacMillan, 1954)

*Fauna and Flora of Nepal Himalaya*, H. Kihara, Ed. (Kyoto Univ., Japan, 1955)

*Garden Flowers in Color*, Daniel J. Foley (Macmillan, 1952)

**The Present-Day Rock Garden*, Sampson Clay (London, 1937)

*Families of Dicotyledons*, Alfred Gundersen (Chronica Botanica Co., Waltham, Mass., 1950)

*Our Northern Shrubs*, Harriet L. Keeler (Scribners, 1903)

*Our Native Trees*, Harriet L. Keeler (Scribners, 1913)

*A Guide to Home Landscaping*, Donald J. Bushey (McGraw-Hill, 1956)

*Color and Design for Every Garden*, H. Stuart Ortloff and Henry B. Raymore (Barrows & Co., New York, 1954)

*The New Book of Lilies*, Jan de Graff (Barrows & Co., New York, 1952)

*American Rose Annual 1956*, Fred J. Nisket, Ed. (American Rose Society, 1956)

*Plant Pathology*, John C. Walker (McGraw-Hill, 1953)

*The Gardener's A B C of Pest and Disease*, A. W. Dimock (Barrows & Co., New York, 1953)

*Garden Enemies*, Cynthia Westcott (Van Nostrand, 1953)

*Historia de las Plantas de Nueva España*, Francisco Hernandez (Mexico, 1952)

*Ground Cover Plants*, Donald Wyman (Macmillan, 1956)

**Rock Garden and Alpine Plants*, Henry Correvon (Macmillan, 1930)

*Botanische Tropenreise*, G. Haberlandt (Leipzig, 1893)

*A Naturalist in Western China*, Ernest H. Wilson (London, 1913)

*Outlines of the Geography of Plants*, F. J. F. Meyen (London, 1846)

*The Art of Growing Miniature Trees, Plants and Landscapes*, Tatsuo Ishimoto (Crown Publishers, New York 1956)

*Japanese Gardens*, Matsunosuke Tatsui (Toyko, 1936)

*Camellias in America*, Harold H. Hume (J. Horace McFarland Co., Harrisburg, Pa., 1955)

*Map of the Landforms of the U. S.* (6th rev. ed. 1952)

**Wild Flowers in the Garden*, Walter E. Th. Ingwersen (London, 1951)

**The Wild Garden*, Margaret McKenny (Doubleday, Doran, 1936)

*A Textbook of Pharmacognosy*, N. M. Ferguson (Macmillan, 1956)

*The Origin, Variation, Immunity and Breeding of Cultivated Plants*, Vol. 13, 1949-50, N. I. Vavilov (Chronica Botanica, Waltham, Mass.)

**Western American Alpines*, Ira N. Gabrielson (Macmillan, 1932)

*Diseases of Fruit Crops*, Harry W. Anderson (McGraw-Hill, 1956)

*Flora of Peru*, James F. MacBride (Field Museum of Natural History, Chicago, 1936)

*Plantae Yucatanae*, Charles F. Millspaugh (Field Columbian Museum, Chicago, 1903)

*Report on the Gums, Resins, Oleo-Resins, and Resinous Products in the India Museum or Produced in India*, Mordecai C. Cooke (London, 1874)

*Elementos de Botanica*, Rudolph A. Philippi (Santiago de Chile, 1869)

*The Root Endophytes of Some Javanese Plants*, J. Janse. Translated by Kenneth D. Doak (Gift of Dr. Doak)

**A Manual of the Study of Insects*, John H. Comstock (Comstock Publishing Co., 1915)

*The World Grows Round My Door*, David Fairchild (Scribners, 1947)

*Lilacs for America*. Report of 1953 Lilac Survey Committee of American Assoc. of Botanical Gardens and Arboretums, 1953

*An Enumeration of Plants in the Albury, Holbrook and Tumbarumba Districts of New South Wales*, E. J. McBarron. Contributions from New South Wales National Herbarium, Vol. 2, No. 2, 1955

*Chinese Flower Arrangement*, Hui-Lin Li (Hedera House, Philadelphia, 1956), (Gift of Dr. Li)

*Plant Diseases*. The Yearbook of Agriculture (U.S.D.A., 1953)

*Animal Diseases*. The Yearbook of Agriculture (U.S.D.A., 1956)

*Illustrations of Medical Botany*, Joseph Carson (Lloyd P. Smith, Philadelphia, 1847)

*The Identification of Trees and Shrubs*, F. K. Makins (London, 1948)

**The American Flower Garden*, Neltje Blanchan (Doubleday, Page & Co., 1913)

*The Indigenous Trees of the Uganda Protectorate*, William J. Eggeling (London, 1951)

*Flora of Bermuda*, Nathaniel L. Britton (Scribner's, 1918)

*Safety for Tree Workers*, A. Robert Thompson. Tree Preservation Bulletin No. 2. Revised 1956.

*Botanical Exploration of the Trans-Mississippi West*, Susan D. McKelvey (Arnold Arboretum, 1955)

**North American Wild Flowers*, Mary V. Walcott. Vol. I-V (Smithsonian Institution, 1925)

**North American Pitcherplants*, Mary V. Walcott (Smithsonian Institution, 1935)

*The Rhododendron and Camellia Year Book 1957* (Royal Hort. Soc., London)

**The Little Garden*, Mrs. Francis King (Atlantic Monthly Press, 1921)

**Adventures with Hardy Bulbs*, Louis B. Wilder (Macmillan, 1936)

*A Flora of Manila*, E. D. Merrill (Manila, 1952), (Gift of Phila. Commercial Museum)

*Standardized Plant Names*, H. P. Kelsey and W. A. Dayton (J. Horace McFarland Co., Harrisburg, Pa., 1942)

*The New Flora and Silva*, Vols. 1-11 (1929-1939) (Vol. 9 missing), E. H. M. Cox, Ed.

***Catalogue of the Vascular Plants of S. Tome*, Arthur W. Exell (London, 1944)

**Select Ferns and Lycopods: British and Exotic*, Benjamin S. Williams (London, 1873)

**My Garden*, Louise B. Wilder (Doubleday, Page & Co., 1920)

*The Useful Plants of West Tropical Africa*, J. Hutchinson and J. M. Dalziel (London, 1937)

**Ferns and How to Grow Them*, G. A. Woolson (Doubleday, Page & Co., 1906)

***An Introduction to the Natural System of Botany*, John Lindley (G. & C. & H. Carvill, New York, 1831)

***The Flora of Whatcom County, State of Washington*, W. C. Muenscher (Ithaca, New York, 1941)

*A Review of the Nearctic Viburnum*, W. L. McAtee (Chapel Hill, N. C., 1956)

***Manual of the New Zealand Flora*, T. F. Cheeseman (Wellington, New Zealand, 1925)

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*Gift of Edgar T. Wherry

**Gift of Philadelphia Academy of Natural Sciences.

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# Arboretum Activities

It is with deep regret that we record the death on July 25th of Miss Janet L. Bowen, Administrative Assistant of the Arboretum. Miss Bowen had served the University in a number of important capacities and came to the Arboretum as Assistant to the Director on July 1, 1954. Her gracious personality and administrative ability will be sadly missed by members of the staff and visitors to the Arboretum.

### PATHOLOGIST JOINS STAFF

On July 1st, Dr. Patricia Allison joined the Staff of the Arboretum as Plant Pathologist. This is a joint appointment by the Arboretum and the Department of Botany of the University.

Dr. Allison did her undergraduate work at the University of Houston and received her master's and doctor's degrees at Ohio State University.

*(Continued on Page 47)*

# We Need Better White Pines for the Northeast

ERNST J. SCHREINER[1]

Thirty or forty years ago the title of this article undoubtedly would have met considerable argument from foresters, lumbermen, and landowners. In colonial days our eastern white pine *(Pinus Strobus)* provided some of the finest lumber for a multitude of uses; the King's Arrow could be found on many majestic white pines reserved for masts for the English navy. Nature had taken a long time to grow those magnificent specimens. Poor-quality trees probably existed in the same proportion as today, but there was such a large natural reserve of white pine that the poor trees could be figuratively "thrown away".

Although eastern white pine has been the most important species for reforestation in New England, it has begun to fall into disrepute because of its susceptibility to white pine blister rust and to the white pine weevil. Foresters and land owners have come to accept blister rust and the necessity for its control as a part of white pine management. But the threat of white pine weevil, which seriously impairs the timber quality and for which there is, as yet, no really satisfactory control, has curtailed the use of this species for reforestation in recent years.

We need an insect- and disease-resistant white pine, but this does not necessarily mean a better eastern white pine. Our conception of a better white pine should be a disease- and insect-resistant tree with growth and wood properties similar to, or better than, our native species. This could be a strain obtained by selection and pedigree breeding with our native stock, a new type derived by hybridization, or it could even be an exotic white pine species.

How can we get better white pines? By the same basic methods plant breeders have used to improve our agricultural plants. Research during the past 20 years has shown that we do have native white pines with sufficient inherent resistance to blister rust to warrant the assumption that we can develop resistant types by selective breeding within the species. We cannot today predict the possibilities of developing a weevil resistant eastern white pine without hybridiza-

[1]In charge, Forest Genetics Research, Northeastern Forest Experiment Station, maintained by the Forest Service, United States Department of Agriculture. The forest genetics work is in cooperation with the Morris Arboretum of the University of Pennsylvania at Philadelphia, Pennsylvania.



Fig. 21. Female flowers (strobili) of eastern white pine at the "bud bursting stage". Female flowers to be used for controlled pollination should be bagged at this stage. (Magnification approximately × 5.) (U. S. Forest Service Photo)



Fig. 22. Male flowers (strobili) of eastern white pine. (Magnification approximately × 2). The flowers at lower right are not yet shedding pollen; lower left just beginning to shed. Short twigs with male flowers at either of these stages may be cut and placed in water for collection of pollen. The flowers at top right and center are shedding pollen profusely. At this stage they may be removed and placed on paper for collection of pollen. The pollen has been completely shed from the strobile at upper left. (U. S. Forest Service Photo)



Fig. 23. Pollen from individual trees can be kept in small vials stoppered with cotton and can be applied with a medicine dropper, preferably drawn out to a rather fine point. The small cotton plug at the top of the medicine dropper prevents the pollen from entering the rubber bulb. Pine pollen can usually be stored for short periods during the breeding season under normal room conditions. Long storage requires special handling. (U. S. Forest Service Photo)



Fig. 24. Female flowers of white pine at the receptive stage. It is at this stage of development that the pollen should be applied for maximum seed-set. (Magnification approximately × 2.5.) (U. S. Forest Service Photo)

tion with other species. The search for, and testing of eastern white pines that appear to be resistant to the weevil has been started so recently that we cannot say definitely that there are (or are not) inherently resistant trees in our forests and plantations.

We have several approaches available for obtaining inherently better white pines for reforestation. Racial variation occurs in most tree species that have a wide geographic range and this appears to be the case in eastern white pine. The Northeastern Forest Experiment Station, in cooperation with the Southeastern, Central, and Lakes States Forest Experiment Stations of the U. S. Forest Service, and the Southern Research Station of the Ontario Department of Lands and Forests, has started a racial test which covers the entire range of eastern white pine. Within the next 10 years this range-wide test should indicate whether or not there are distinct races, and the probable adaptability of such races throughout the Northeastern region.

Selection of superior individual trees in natural stands and in plantations is also underway at the present time. Such superior trees can be used in breeding and they can also be grafted and grown in isolated seed orchards, plantations designed to produce superior seed for commercial use. The technique for establishing such seed plantations and for testing the individual selections for their breeding quality is beyond the scope of this paper.

Trees superior in resistance to pests, growth rate or timber form have been used in our

*(Continued on Page 48)*



Fig. 25. Female flowers bagged with sausage casing for controlled pollination. The pollen may be dusted on the female flowers (when they are receptive) by puncturing the bag with a medicine dropper and then sealing the hole with scotch tape. Note that the individual flowering branch is tagged to identify the parentage of the controlled pollination. Cotton is wrapped around the twig to keep wind-blown pollen out of the bag. (U. S. Forest Service Photo)

# What's Your Trouble?

Patricia Allison

Surely there can be no more exquisite anguish than that of the gardener with trouble. Usually this distress does not lie in the fact that the living vista he is trying to create falls just short of the glories of the seed catalog or the splendors of the home magazine. To the contrary, the real trouble comes when his personal struggle with nature seems to be swinging in the wrong direction — toward actual loss of the green objects of his labor to say nothing of his investment. This type of trouble does not include damage by hurricanes, fires or small boys with hatchets, which is vastly more acceptable than his real troubles. No, the causes of genuine worry seem mysterious beyond measure and remediable only through some rare and thoroughly random stroke of luck. They are PLANT DISEASES AND PESTS. His principal object, then, is to increase his chances of successful remedy and his doubts about how to proceed are certainly justifiable.

Many have long been aware that such pests as insects can cause really grave damage to all sorts of plants. Even now, however, not many who are non-gardeners even know that plants can be diseased, let alone that diseases cause about three billion dollars worth of damage in the United States each year. The arrays of garden chemicals in hardware and department stores are doing much to create awareness as well as to provide means for control. They have also done much to create confusion. "What shall I buy?" "Should I buy a fungicide or an insecticide?" are questions commonly heard by specialists in retail merchandising. The answers to these questions and many like them depend wholly on knowing the cause of the trouble. Only with at least a general knowledge of causes can a general notion of remedies be formed. And before we can gain a general awareness of causes of trouble we must become skilled in seeing trouble when it's there. So we come to a natural sequence of questions the answers to which can increase the chances of achieving that elusive solution to diseases and pest problems:

1. Are my plants healthy?
2. If not, what is the cause of their trouble? Animate or inanimate? Disease or pest?
3. What can I do to rid my plants of their enemies?
4. If I can't decide, where can I go for help?

The answer to the first question depends on knowledge of the healthy characteristics of the varieties planted which can be gained in any number of ways. Visits to other gardens, looking at nursery catalog illustrations (judiciously), or through illustrated garden books are helpful.

The answer to the second is the most difficult of all and it is small comfort indeed to know that in general plant pathologists work with diseases and entomologists work with insects. (As a matter of fact many insects cause diseases and entomologists may be quite concerned with creatures that are not insects!) Plant diseases are generally considered to be harmful changes in the inner workings of plants brought about by the relatively prolonged influence of certain environmental agents. Such harmful changes result in *symptoms,* such as stunting, yellowing, galling, wilting, spotting, or rotting. Now, it is very important to note that the symptoms are not the disease, but the results of the disease.

The *environmental agents* (causal agents, incitants) may be inanimate or animate, resulting in the so-called nonparasitic and parasitic diseases respectively.

It is equally important to note that the causal agents are not the disease either. As a matter of fact, many of the living incitants of plant disease spend only a small portion of their lives causing trouble. The remainder of the time they may be doing something quite acceptable, or resting up, or making life difficult for an entirely different sort of plant.

## Types of Causal Agents

Presently we will go on to a consideration of the appearance of unhealthy plants which, of course, is the main clue for the amateur in diagnosing his general category of trouble. Brief mention should be made of the types of causal agents first. We will begin with animate ones. Here it would be helpful to recall that green plants occupy an exceedingly high position among all living things. By virtue of a single peculiarity of their inner workings, the entire living world is able to survive. This peculiarity is the physiological process known as photosynthesis, by means of which green leaves transform carbon dioxide, water, and light energy into one or more simple foods. Minerals from the soil are combined with the products of photosynthesis

and molded into still other and more complex foods. On this source of food-energy virtually all other creatures depend, including the parasites. It is not surprising then that the same general groups of organisms that have representatives which are pathogenic to man also contain species pathogenic to plants. The main groups are bacteria, fungi, nematodes (round worms), and insects, two groups of non-green plants (and hence dependent on an external source of food), and two groups of animals (likewise dependent on an external source).

The first three groups have a characteristic in common that was of importance in delaying the discovery of their nefarious ways. This is their extremely small size. To be sure, any of them may be visible in the aggregate but at least portions of them such as fungus spores, or nematode eggs may be microscopic. The whole bacterium body, of course, is invisible without optical aids. Not much more than a hundred years ago, even when wefts of fungus threads (mycelium) had been observed time and again on the surface of diseased plants, it was thought by most scientists that they were products of the sick plants rather than causes of the disease. Indeed, it is difficult to believe that a single microscopic spore that is blown by the wind or splashed by the rain can alight on healthy green foliage, germinate like an infinitesimal seedling, push Lilliputian branches through the waxy coat, then between cells or through cells, scavenging food, dissolving walls, releasing toxins, disrupting photosynthesis, killing tissues, then erupt once more and thrust into the air a quarter million spores of its own — all within a few days' time!

### Bacteria

Most of the pathogens (living organisms that can cause disease) of man are species of bacteria. This is not true of plant pathogens. One of the most famous controversies between scientists was in full sway only some 80 years ago over whether or not bacteria could cause plant diseases at all! Now it is known that some 300 species of these microscopic one-celled plants do just that. The types of diseases and symptoms are diverse. Many of them have been limiting factors in the production of crop plants and some of them are very serious in ornamental plantings. Fireblight, for example, eliminated commercial pear production in the Midwest, and even now causes great damage to several varieties of apples in that area as well as to pears on the West Coast. Bacteria are carried from cankers on stems to young flowers which then die back along with part of the twigs. From these new diseased areas bacteria are carried to other tender shoots where the process is repeated. Frequently an orchard appears to have been scorched by a giant blow torch. The same species of bacterium may cause similar symptoms on a number of Rosaceous ornamentals.

Any part of a plant may be affected by bacterial pathogens. Some cause local dead areas (necrotic lesions); some get in the vascular tissues, resulting in interruption of water and food transport and causing wilts; others induce the host plant to form more and more cells resulting in large tumors or galls on roots or stems. Indeed, one of the gall diseases has been the subject of intensive study for a number of years, since there is much to be learned about tumor induction in general if a thorough understanding of such diseases of man is to be attained. This disease is called crowngall, for the overgrowths are commonly located at about ground level. Diseased nursery stock is always condemned, frequently at considerable monetary loss, when this disease is discovered, as it is one of the most difficult of all to control.

The bacteria usually overwinter in or on host tissue. When weather conditions are warm and moist in Spring, reproduction of the bacterial cells is resumed at an extremely rapid rate, often resulting in the formation of a slimy ooze on twigs or other parts. The cells are transferred to new host plants by splashing rain; or by insects, tools, and implements; or in the seed from which a new plant arises. Some bacterial diseases are easy to control; others exceedingly difficult.

### Fungi

The fungi are a vast and varied assemblage of non-green plants. (Some people include bacteria in the same group with the fungi). Two of the most familiar representatives are the noble mushroom, companion in perfection with the beefsteak; and the filamentous bread mold, insidious invader of the staff of life. Both of these are saprophytes; that is, they obtain their food from dead organic matter. Both form spores in fruiting bodies. In the case of the mushroom, a "higher fleshy fungus," the fruiting body is large, intricate in design, and soul-satisfying in flavor. It arises, however, from a very extensive weft of vegetative mycelium or threads buried in the substratum. This mycelium resembles that of many other fungi, including the bread mold. The fruiting structure of the latter is very simple in comparison, consisting of a minute stalk topped by many many spores in an ephemeral sac. Some idea of the numbers of spores which may develop can be obtained from the familiar green mold on oranges. That green powder which puffs about is composed of billions of spores.

The plant pathogenic fungi are not confined to any one of the major groups of fungi. Some have complex, fleshy fruiting bodies, others have not. Most form spores of some kind. Indeed the rust fungi may have as many as five different types of spores in their complex life cycles. In addition to variety in structure, there is extreme variety in feeding habits. Some are fastidious to the extent that they can complete their life cycles only on the living host plant, perhaps being restricted to only one or a few species of host at that. Some affect only certain parts. Others are omnivorous, existing from year to year entirely on non-living materials, becoming parasitic only when a host plant is weakened by some other sort of disease or by injury. Another type of omnivorous fungus may parasitize plants from hundreds of different species.

As you might expect, the symptoms of the diseases incited by these organisms are variable too. Any part of a plant may be attacked above or below ground. Some are wilters, some are spotters. Some are blighters, others rotters. Some cause overgrowths in number or size of cells. Others cause undergrowth as in stunting or chlorosis (abnormal deficiency of green pigment). Some fungi, like those causing damping off of seedlings, kill their host plants outright and promptly. Others live in relative harmony with the green plants, obtaining food and a place to stay at little or no expense to their hosts, like the powdery mildew fungus on lilac. Since the fungi are living things, there is also a considerable amount of activity among themselves, resulting in the formation of new races or biotypes with new combinations of characteristics. The same can be said for any of the major groups of pathogens, of course.

### Nematodes

The nematodes are members of one of the major groups of invertebrate animals called the round worms. Their bodies are usually long and slender and there are large ones as well as small ones. Certain members of this group are parasites of man and other vertebrate animals, such as the one of common occurrence in pork that causes trichinosis. The pinworm is another. Plant parasitic nematodes are in general quite small. The largest of them can just barely be seen with the unaided eye. All of them are thought to be obligately parasitic; that is, they obtain food only from living tissues. They are well equipped for such a role, as each possesses a built-in miniature hypodermic needle that can puncture cells and extract juices. A good many of them are sedentary, living in or attached to the host plant. Others wander around inside the tissues channeling their way from place to place. Still others are the grazing type, puncturing from the outside, feeding for awhile, then moving along to greener pastures. Although the damage caused by some of these creatures has been known for a long time, recent research has revealed that there may be far more parasitic species than imagined before. Furthermore, it has already been found that attacks by nematodes may completely destroy natural resistance of plants to certain fungi and bacteria. Most of the nemas attack underground parts, but there are some that feed and reproduce in stems, leaves and flower parts. The eggs, larvae or cysts of certain representatives are extremely resistant, surviving for years and years in soil or plant parts.

### Chewing Insects

Insects affecting plants have come to be thought of mainly as "pests." This is regrettable especially when the plants concerned are perennials. One reason this jargon has developed is that a good bit of insect damage, especially to crops, is not the result of disease at all. Let's consider the general types of insects and their relatives that harm plants. There are the chewers, those voracious creatures such as grasshoppers, caterpillers, beetles, borers, grubs, wire-worms, and leaf miners. The grasshopper alone has been called the principal grazing animal of the world. Whether or not they may cause disease is somewhat obscured by the fact that there are such severe economic losses to crop plants, many of which are annuals. The yields can be reduced enormously. Now, yield reduction is often a symptom of disease, but in this case, yields are not necessarily reduced through alteration in the food making or storing capacities of the plants. To the contrary in many instances the yields have been amputated (ambushed?) and consumed by the wrong parties. This does not alter the fact, however, that these jumping, crawling, flying appetites do cause disease. The removal of significant portions of the green foliage of plants, for example, obviously reduces their capacity for food making. Among perennials this leads to gradual reduction in vigor if the attacks are repeated year after year. Resistance to other organisms and environmental conditions is reduced.

Many of the chewing insects kill whole plants without removing large portions. Among them are the cutworms and grubs living in soil or near the soil line. Others, by their activity in vascular tissue, may interrupt water transport causing wilt symptoms.

### Sucking Insects

The other main feeding type of 6-legged creatures, the sucking insects, causes a wide variety of

symptoms. Aphids, leaf hoppers, scales, mealy bugs, and spittlebugs, all insert their mouth parts into the host plant and suck juices from it. The appearance of the victim is altered in many ways. When young succulent foliage is attacked, for example, contortion of the developing shoots and leaf blades follows. Others, through their many minute punctures on leaves, cause an overall chlorosis, stippling, or bronzing. Some apparently secrete a toxin into the host plant, as do the potato leaf hoppers. The Harlequin bug and squash bug cause almost immediate wilting of the entire host plant soon after they feed in a localized area of the stem. Some cause galls of roots, leaves, or stems thus revealing a profound localized change in host physiology. (This also happens after many species of wasps have inserted their eggs into plant tissue.)

### Mites

Now would be a good time to mention a group of insect relatives that are serious enemies of plants. These are the tiny mites and spider mites. If you really want to jolt that hardware store clerk, go in and ask for an acaricide. Since mites are not insects and since special means of control are frequently necessary, the purists call the chemicals which do the trick acaricides after the name of the group to which the mites belong, Acarina. Uncle Sam takes a much more commercial view and calls them insecticides. At any rate, if special control measures are sometimes necessary, you can rest assured that what the animals do to plants is of considerable concern. They are very small (barely visible) and feed on many different plant parts. They may cause leaf distortion, bronzing, and shedding. Others injure fruits. One group causes severe overgrowths in flower parts and buds. Frequently they form a thin veil of web on the underside of leaves.

### Dissemination of Pathogens by Insects

As if this grand miscellany of insect damages were not enough, there is yet another type of insect villainy that does not bring joy to him who cultures plants of any kind. Many species of insects are great beasts of burden that carry within or on their bodies a variety of other plant pathogens. These they may deposit on the surface of appropriate hosts during their wanderings, or they may actually inject them into the plant tissues. Frequently the arrangement between pathogen and insect is not one of mere chance mechanical transport, but a highly specialized relationship resulting in the shelter of the pathogen over winter, followed by the careful deposit of it at the proper site at the crucial moment. Sometimes the disease incitants may actually increase in number within the body of the insects. Many of the bacterial or fungal pathogens so transported may be disseminated by other means as well, but there are a number of exclusive ones that can be sheltered and disseminated only by such insects. Naturally, then, control of the insect pays dividends by preventing the bacterial or fungal disease.

### Viruses

While we're on this general subject it is a good time to mention another very large and important group of causal agents of plant diseases. At the beginning we mentioned the somewhat obvious fact that causal agents of disease could be classified into two broad categories, living and non-living. At this juncture we must confess that we just don't know whether or not members of a large group of serious disease incitants are living or not. These are the viruses, those extraordinary complex protein molecules that induce host plants to form more of them and cause damages worth millions in the process. Insects, leafhoppers and aphids especially, are extremely important in disseminating viruses and injecting them into plants. Again, some relationships are casual, others intimate. So many of the viruses are transmitted this way, that insect control is of prime importance. Other plant viruses can be transmitted through wounds such as those caused by grafting or cultivating instruments or merely by brushing a plant with a shirt sleeve. They cannot be cultured on artificial media.

Symptoms of virus-incited diseases are fully as diverse as those of any of the diseases caused by parasites, such as spotting, stunting, chlorosis, wilting, rotting, and tumor formation. In addition there are a number of devious subtleties. The commonest site of symptom expression is the newest growth. Young foliage may be distorted beyond recognition, yet older parts, which nevertheless contain virus particles, can remain apparently healthy. One of the commonest types of symptom is called mosaic. Leaves are mottled with light and dark green patches, some of which may be raised. Another type closely allied to mottling is variegation. Bright yellow or white spots occur on leaves or flowers. You may have some virus-diseased plants, for a number of exotic variegated ornamentals are not variegated as a result of their own inherent characters, but because a virus has somehow contaminated a non-variegated variety and the diseased stock has been perpetuated by vegetative propagation.

Sometimes there is no visible evidence that a plant contains a virus, yet the virus can be transmitted to another host plant where symptoms occur.

A considerable number of diseases have been described that are caused by two viruses acting together, the combination resulting in a set of symptoms quite different from those characteristic of the effect of either virus alone.

### Non-Living Causal Agents

Subtle as some of these symptoms may be, they cannot match those of the diseases caused by truly non-living environmental factors, where excesses and deficiences are often relative rather than absolute. This makes them no less important as far as the health of the plant is concerned. In considering the vagaries of the non-living environment of plants it is well to bear in mind that most higher plants live in two different worlds at the same time: the air and the soil. How many living things do you know of that spend most of their lives under such circumstances? On the one hand the environment is relatively dry, filled with gases of various sorts, sparsely inhabited by a few flying things or tiny blown about creatures and subject to frequent large variations in temperature. The lower regions, however, are dark as can be, moist, crowded with mineral and organic matter, and teeming with small plants and animals. Add to this the wonder of intertwined activities of the top of the plant and its roots, and the stage is set for a display of reactions giving rise to every conceivable overt symptom. The most delightful symptoms of interaction, of course, are the richness of foliage and vigor of growth of the plant able to handle variation in its environment. When water losses and food making activities of the foliage are in balance with the water and mineral intake, and food utilization of the root system, all's right with the world. But let there be a serious imbalance, as when the air is exceedingly dry and the ground not correspondingly moist, normal growth ceases. So it is that water shortages, mineral deficiencies or excesses, and temperature extremes cause many symptoms of disease. Plants wilt, become mottled, spotted, chlorotic or bronzed, shed leaves prematurely, get cankers or distorted fruits, all through the agency of *relatively* extreme variations in nonliving environment.

### Diagnosing

It now appears that the only causes of diseases not operative in the plant kingdom are the psychosomatic ones! This invites a discussion of the weeping willow, but we have yet to dwell a little on a serious question. How in the world do you find out which of all these agents that may induce the same symptom development is actually to be blamed in a particular instance?

Take heart. Many plant troubles, such as black spot of rose, can be identified by their very typical symptoms.

There is another bit of encouragement. Symptoms alone are not the whole story. Anyone who has seen powdery mildew of lilac can spot the same disease of just about any other type of plant there is even though many different species of related fungi cause the disease. Similarly, anyone who has seen the orange rust on hawthorn or apple, might suspect correctly that the strange orange powder-filled protuberances on pine needles are caused by a related fungus. What is it that indicates causal agent in these two examples? It is the causal agent itself. The symptoms of a powdery mildew disease often include yellowing or browning of leaves and distortion of young shoots and buds (as on roses), but these are symptoms that could be caused by any number of things. Aphids on roses, for example, also cause shoot and bud distortion. It is that powdery white coating on the upper surface of lilac leaves that distinguishes the disease, and that coating is the mycelium of the fungus itself. And it is the sight of the aphid itself that is the tip-off to its own damage on roses. So, in addition to symptoms of the disease that help us in solving the identity problem, there are the signs of the culprits themselves. Often they don't leave the scenes of their crimes. Leaf spots, for example, may have dark pin-point specks in their centers — a suggestion that a fungus has caused the spot and has formed its minute fruiting bodies there.

Yet another comfort is the fact that each of the plants found in the garden has its own family of most common troubles which have been described and illustrated for the amateur diagnostician by several able professionals. Specific control measures are given for each trouble. One of the most faithful of all the gardener's literary friends has been Dr. Cynthia Westcott. Several of her books are cited at the end of this article. Another recent publication by a plant pathologist is Dr. A. W. Dimock's "The Gardener's A B C of Pest and Disease," concise, down-to-earth, practical, and entertaining as well. Dr. P. P. Pirone has also written for the amateur. If you are curious about plant diseases in general and how they have influenced man's progress from ancient times onward, take a look at the books by E. C. Large and Stevens and Stevens.

### Control Recommendations

Recommendations for control in any book on plant diseases are based on principles that have been developed from years of research on the life histories and means of dissemination of causal

agents; on the diseases and the influence of environment on them; and on the resistance of different plant varieties to insects and disease, as well as on chemicals and their application methods.

These principles of plant disease control will be discussed at greater length in another article, but it should be emphasized here that the main objective behind all control methods is to *prevent* disease, either to keep it from developing at all or to curtail further development once begun. No amount of fertilizing, watering, or spraying with exotic brews will make a dead branch come back to life! This is why the gardener who really enjoys his hobby develops a sharp eye and inquisitive reading habits. "One swallow does not a summer make," but one leaf spot may be a vision of things to come!

READING SUGGESTIONS


Dimock, A. W. The Gardener's A B C of Pest and Disease. 191 pp. M. Barrows and Company, Inc., New York. 1953. $2.95

Large, E. C. The Advance of the Fungi. 488 pp. Henry Holt and Company. New York. 1940. $5.00.

Pirone, P. P. Maintenance of Shade and Ornamental Trees. 2nd ed. 436 pp. Oxford University Press, New York. 1948. $8.00.

————————. Modern Gardening. 371 pp. Simon and Schuster, New York. 1952.

Stevens, Neil E. and Russell B. Stevens. Disease in Plants. 215 pp. Chronical Botanica Company, Waltham, Mass. 1952. $4.75.

Westcott, Cynthia. Garden Enemies. 261 pp. D. Van Nostrand Company, Inc., New York. 1953. $3.75.

————————. The Gardener's Bug Book. 590 pp. Doubleday and Company, Garden City, N. Y. 1946. $5.95.

————————. Plant Disease Handbook. 746 pp. D. Van Nostrand Company, Inc., New York. 1950. $8.50.

————————. The Plant Doctor. 231 pp. J. B. Lippincott Company, Philadelphia, Pa. 3rd ed. 1950, 1953. $3.00.


# Plants for Associates


Mary O. Milton, Propagator


In the past the Arboretum has distributed plants to a relatively small number of Associates. Now our number of Associates has increased to a point where there are widely varied garden types to be considered and one general plant type no longer meets the requirements of the majority of gardens. Therefore, we would like to have you write to us and indicate the type, or even specific plant you feel is needed for your particular soil, space, and landscaping plan.

Although we may not be able to meet each personal request we do of course want to furnish suitable plants for a greater number of Associates.

You might include in your list plants which you have found difficult to obtain through commercial sources. And of course your request for a less well known plant might well bring it to the attention of others who have either not known the plant at all, or perhaps knew the plant but had not considered it as having merit for use in a home garden. In this way a more general acquaintance and appreciation of the less well known plants can be made.

While we are inviting your correspondence on the above we would like to know, too, your thoughts on changing the time of our plant distribution from Fall to Spring. Our greenhouse and nursery area is limited and a great deal of labor is involved in repeated repottings. It is necessary, therefore, to limit the size of plants distributed to that which will fit into a four inch pot. This means that the plant you receive is usually about two years old and has spent its entire life either in the greenhouse or in a coldframe. Since most plants require a period of "hardening-off" to enable them to adjust to a sudden change in temperature you are faced with either coddling them through the winter in a sheltered place, or taking a chance and planting them out in the Fall. Last year's instructions for carrying the plant through the winter were somewhat involved for some of the Associates; many had no suitable place to keep them, and as a result some plants were killed during the winter. It is thought, then, that Spring rather than Fall distribution would be better.

In order that your letters or cards in answer to the above can be quickly separated from the general Arboretum correspondence, please address them to the Propagator.

# Arboretum Activities

*(Continued from Page 38)*

She served for a number of years as Research Associate at the O.S.U. Research Foundation and immediately prior to coming to the Arboretum had been engaged in teaching and research at the University of Minnesota.

The appointment of Dr. Allison makes possible the establishment of an active research program in experimental plant pathology and mycology at the Arboretum. Particular attention will be given to the diseases of woody ornamental plants and for the first time in many years the Arboretum will be in a position to give technical advice to the public on matters relating to this important subject.

Readers of this issue will be introduced to Dr. Allison through the medium of her informative article "What's Your Trouble?"

### Dr. Li Visits England

On August 26th, Dr. H. L. Li, Taxonomist on the Arboretum Staff, left with his family for a three months' stay in England.

Dr. Li is the recipient of a grant from the National Science Foundation for the purpose of studying the trees and shrubs of Formosa. His trip to England will enable him to study the rich collections of Formosan plants at Kew and the British Museum. He will also visit a number of large herbaria on the continent.

### Drug Plant Garden

It is a pleasure to report that the Garden Club of America at its forty-fourth annual meeting held at Winnetka, Ill., in May presented its Founder's Fund Award to the Morris Arboretum for the purpose of establishing a Medicinal Plant Garden. This award of $2200 will enable the Arboretum to carry out a project which has long been entertained, namely, the development of a living collection of the important drug plants of the world.

Many of the famous gardens of the sixteenth and seventeenth centuries were primarily collections of medicinal herbs. Indeed systematic botany may be said to owe its beginning very largely to the attempts to describe and classify the therapeutic properties of plants. It is therefore highly appropriate that today, when there is such a renascence of interest in natural products as the source of drugs, some attention be devoted to this important group of plants.

The new Drug Plant Garden will be located on a gentle slope just below the Rose Garden, where it can readily be viewed by visitors. Of unusual interest will be the fact that in addition to hardy species, such as Digitalis and Aconite, it will contain numerous tropical and subtropical drug plants like Ipecac, Quinine and Rauwolfia. The latter group will of course, be moved into a greenhouse during cold months.

It is expected that this garden will be of interest to students from schools of medicine and pharmacy as well as to the general public. A descriptive pamphlet telling of the medicinal value of each species is being prepared and will be available for distribution when the Drug Plant Garden is formally opened.

A future issue of this Bulletin will carry a detailed account of the Garden with the information concerning the date on which it will be ready for inspection.

The Arboretum is most grateful to the Officers and Members of the Four Counties Garden Club and the Garden Club of Allegheny County who sponsored this project.

### Survey of the Grounds

Visitors to the Arboretum this summer will have noticed large numbers of wooden stakes driven into the ground at regular intervals. This is part of a much-needed survey of our 170 acres that is being conducted by a team of Civil Engineering students from the University's Towne School.

The entire property is being laid out in grids or squares 200 feet on a side. This autumn the wooden stakes which mark the corners of these squares will be replaced by concrete markers or "monuments" set flush with the ground in order to facilitate mowing.

Once this survey has been completed it will be possible to prepare a set of master maps, one for each square, on which the exact position of every plant will be shown. These maps which will be drawn on linen, with a scale of one inch equaling ten feet, will constitute a valuable addition to our archives, and will enable us to record with precision the location of each of the many thousands of individual trees and shrubs.

### Renovation of Fernery

One of the truly unique features of the Arboretum is the tropical fern-house which was designed by Mr. Morris and constructed near the beginning of the century. In recent years the roof of this structure had become so weakened that it was necessary to close the Fernery to the public.

This summer our able builder, Mr. Thomas Carney with the aid of two assistants has completely reconstructed the roof, using new steel supports and struts and replacing all of the wooden frames with California redwood. Motorized vent control is being installed and a special type of new glass is being used throughout. When the Fernery is re-opened this Autumn it will be tighter and stronger than ever and visitors once again will be able to enjoy one of the Arboretum's most attractive features.

### Shade Tree Conference

The National Shade Tree Conference held its 33rd annual meeting at the Sheraton Hotel in Philadelphia from August 26 to 30. Several members of the staff attended these meetings and a number of participants visited the Arboretum.

Upon invitation the Arboretum arranged a small exhibit which was set up in the Educational Exhibition Area at the hotel. In it we featured a display of dwarfed tree materials or "bonsai" kindly made available by Dr. Li from his personal collection. We also featured, with illustrative material, two articles which have recently appeared in this Bulletin, namely, Dr. Li's paper on "The Origin and History of the Cultivated Plane Trees" and Dr. J. W. Wright's article entitled, "Cultivated Firs in the Philadelphia Area."

According to the Chairman of the Exhibits Committee the Arboretum's display elicited many favorable comments and was by far the most educational of all the exhibits.

### The Summer Course

For the third successive summer there was conducted at the Arboretum a college-level course devoted to the Identification of Woody Plants. This year the course was one of a series of six courses to which were admitted participants of the National Science Foundation's Summer Institute for High School Teachers of Science and Mathematics. As a result nine members of a class of twenty were high-school teachers who were enrolled as N. S. F. Scholarship holders. This group included representatives from as far west as Michigan and as far south as North Carolina. Four other members of the class were graduate students of Landscape Architecture who took the course in order to acquire a better knowledge of plant materials.

As in the past, the formal laboratory work was conducted on the ample verandas of the Gates Building and the class spent approximately two hours each day on the grounds becoming acquainted with the living plants. In addition to the day-by-day work of identification, the students received instruction in such related subjects as propagation, disease recognition and control, ecology, forest genetics, and a number of others.

J. M. F., Jr.

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## Better White Pines

*(Continued from Page 40)*

breeding work at the Morris Arboretum. There are ten exotic white pines that have been grown for a sufficiently long time in this region to indicate their hardiness. These are not all timber types but it is possible that even the non-timber trees may carry desirable inherent qualities such as resistance to insects or disease. We expect to test those exotic species with good timber form in their native range, in forest plantations in the Northeast.

Our controlled white pine breeding methods at the Morris Arboretum are essentially the same as those used in the breeding of agricultural plants. The female flowers are covered with a bag before they are receptive to pollen (fig. 21) to protect them against natural pollination. Pollen collected from male flowers (fig. 22) of the desired male parent, is stored in cotton-stoppered vials (fig. 23) in the refrigerator at 25 percent humidity until the female flowers are receptive (fig. 24). Pollination is accomplished by puncturing the covering bag (fig. 25) and blowing a small amount of pollen from a pollen-filled pipette (fig. 24) directly on the open flowers.

Tree breeding requires patience; compared to agricultural crops, trees grow slowly. The seedlings derived from controlled pollination are still too young to evaluate the results of our breeding work. It will be at least five years before estimates on probable growth and pest resistance will be available.

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*Metasequoia at the Morris Arboretum*

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# Arboretum Activities

## The Staff

Dr. Patricia Allison, Pathologist, attended the annual meetings of the American Institute of Biological Sciences which were held at Stanford University, August 25-29. She presented a paper entitled "The Mutagenic and Injurious Effect of Filipin on *Helminthosporium sativum*," in co-authorship with Dr. J. J. Christensen of the University of Minnesota. Dr. Christensen is an Associate of the Morris Arboretum.

In addition to her duties at the Arboretum Dr. Allison is giving a course on the Morphology of the Lower Plants in the Department of Botany on the University campus.

The Director has recently given an illustrated lecture entitled "Exploring for Drug Plants in Southern Asia," to the following organizations: Garden Club of America, October 9; Bala Cynwyd Garden Club, November 7; Four Counties Garden Club, November 12; Women's Club of Downington, November 13. On October 23 he was the principal speaker at a dinner commemorating the 85th Anniversary of the Germantown

*(Continued on Page 60)*

# The Discovery and Cultivation of Metasequoia

Hui-Lin Li

The discovery in 1941 of a living species of *Metasequoia* aroused widespread interest in botanical and horticultural circles. The revelation of the existence of a new type of conifer is in itself highly significant, but the impact of this discovery upon paleobotany, the study of the past history of plants, is even greater. Its very existence means that many long established concepts of Tertiary botany, based upon fossils alone, must now be re-examined and revised. Thanks to *Metasequoia,* we have gained new insight into the conditions which lead to the development and formation of our present day vegetation. The story of its discovery has been frequently recounted in many languages, but it is one that deserves to reach an ever-widening public.[1]

The universal interest engendered by this intriguing conifer is reflected in a voluminous and rapidly increasing literature. Since its formal designation as *M. glyptostroboides* in 1948 it has been a constant subject of scientific study and publication. In 1950 Chu and Cooper enumerated 54 articles devoted to it and in 1952 Florin cited no fewer than 130; the number must have increased several fold since that time.

Within a few years of its discovery seeds of *Metasequoia* were distributed to all important botanical gardens and arboretums throughout the world. It is now widely cultivated in Europe, Asia and North America as well as in some parts of the Southern Hemisphere. Since stock is now available from several trade sources its cultivation has also spread to many private gardens. Probably no plant has ever been accorded such rapid and wide-spread recognition and dissemination, a phenomenon made possible only in this modern age of swift world-wide transportation and communication.

## Establishment of the Genus

To begin our story we must go back at least a century. Almost a hundred years ago a fossil plant, later known as *Sequoia Langsdorfii* (Brongniart) Heer, made its appearance in the literature. This plant was shown to be wide-spread in the Eocene at high northern altitudes and at middle latitudes in North America and Asia. Subsequently many other similar fossil plants were discovered and described by paleobotanists. Most of these were named as species of *Sequoia* for they were believed to be related or ancestral to the living Redwood *Sequoia* (including *Sequoiadendron,* the Bigtree) of California. Others were referred to as *Taxodium,* in the belief that they were assignable to the same genus as the living Bald Cypress of Southeastern U. S. A. and Mexico. These fossil plants, on the strength of their presumed identity with these modern genera, are used by paleobotanists as a basis for constructing various theories about Tertiary vegetations in the Northern Hemisphere, their ecology, migration and evolution.

Many of these fossil plants, including the most widely recorded *Sequoia Langsdorfii,* however, do not exactly resemble the modern *Sequoia, Sequoiadendron,* or *Taxodium,* for they bear, among other things, oppositely arranged branches and leaves, while, contrastingly, all these modern genera have alternately arranged ones. This very obvious and distinct taxonomic character, interestingly enough, was completely overlooked by paleobotanists for nearly a century. Even though the material available to paleobotanists is always fragmentary, this character nevertheless is readily recognizable in nearly every specimen.

It remained for a taxonomist, the Japanese botanist Miki, a specialist on living aquatic plants, to make the long overdue diagnosis. He by chance discovered and studied some fossils and noted the striking character of opposite leaves of some that had long been credited to *Sequoia.* He also noted that the cones have decussate scales and long slender stalks. As all these characters are manifestly different from *Sequoia* or *Taxodium,* he established a new genus *Metasequoia* (1941), *meta,* from the Latin meaning "beyond," in allusion to their possible relationship.

## Discovery of a Living Species

When Miki established the genus *Metasequoia,* it was still known only as a fossil genus, one which supposedly had long been extinct. But strangely enough in the very same year, the year of a great war in eastern Asia, on the other side of the battle front, a Chinese botanist was

[1] Cover illustration by Mr. Wm. Richard Carpenter. All other photographs made by Dr. J. L. Gressitt in China in 1948 and published through the courtesy of the California Academy of Sciences.

also discovering a living tree, entirely unknown to science, but belonging to this very same genus. It is a strange coincidence, and indeed a fortunate one for science, and apparently one of the few good things coming out of the last destructive world war.

In 1937 Japan invaded China. In subsequent years the Chinese government retreated to the interior in the mountainous west and dedicated itself to prolonged resistance. Exploration parties were dispatched to little known regions in the hinterland of the country to survey and explore natural resources. At the end of 1941, T. Kan of the National Central University, while visiting the village of Mo-tao-chi, in eastern Szechuan province, first noted a peculiar deciduous conifer locally called "shui-sha" or water-fir; no specimen was then collected and it was not until the summer of 1944 that T. Wang of the Central Bureau of Forest Research collected foliage specimens and cones from the same locality. The discovery of this new conifer was first made known through publication in 1946, and was named and described as *M. glyptostroboides* by H. H. Hu and W. C. Cheng in 1948. The specific epithet referred to its resemblance to *Glyptostrobus*, a deciduous conifer of Southern China.

### Introduction into Cultivation

From 1946 to 1948 Cheng sent out several expeditions to the area to collect herbarium specimens and seeds. In the meantime Dr. E. D. Merrill of the Arnold Arboretum, upon receiving herbarium specimens collected by C. J. Hsieh in 1946, realized the significance of the find and the importance of obtaining seed for propagation. With the aid of a grant made by the Arnold Arboretum, an expedition was sent out by Cheng for obtaining seed. Hsieh and C. T. Hwa were members of the party. Their exploration revealed the existence of a hundred or so large trees of *Metasequoia,* covering an area of about 800 square kilometers. The center of distribution is in the Shui-sha Valley in Hupeh province, where over 1,000 trees were found, many of them of small size and not a few planted.

A large quantity of seed was obtained and subsequently widely distributed in China, the United States and many other countries. The wide distribution of seed to botanical gardens throughout the world made by Dr. Merrill is largely responsible for its present great popularity today.

Since then the tree has been successfully raised in many parts of the world. In spite of the small area of its original habitat, it has proved hardy in widely separated regions of different continents, including such northern localities as Norway, Sweden, Finland, Southern Alaska and Central Vermont. It likewise thrives in all temperate countries.

*Metasequoia* is a rapid growing tree when young. Among the plants grown from seed sown

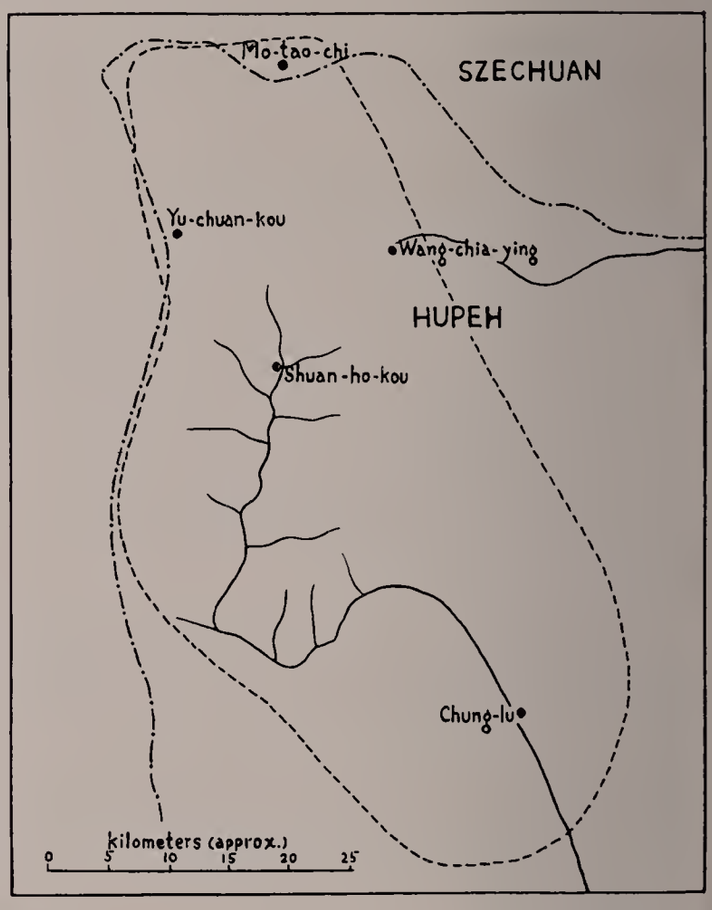



Fig. 26. *A*. A map showing the approximate limits of *Metasequoia* (indicated by dotted line).




Fig. 26. *B*. Map of China showing location of A (indicated by black dot).



Fig. 27. A view of the Shui-sha Valley. Note the terraced rice paddies.

in April 1948 at the Morris Arboretum, the tallest reached a height of 5 feet 9 inches in 1949 (Skinner 1949) and now in 1957, it measures about 20 feet. (See Cover) A tree planted upon a slope has grown as fast as one planted near a pond. As much as 57 inches of growth has been observed in a single season. This rapid rate of growth is unsurpassed by any other conifers we have noted. The trees are not only rapid growing but also of well formed pyramidal shape. When the leader is damaged, it is rapidly replaced without any deformation.

In many localities trees grown since 1948 have already been reported to bear female cones. At least three such instances have come to our notice, one along the Pacific Coast, a second in New York and a third in England. In none of these cases were male flowers noted, so the cones were apparently sterile.

Although it may be many more years before most of the trees in cultivation will bear male as well as female cones and thus produce viable seeds, fortunately the tree is readily propagated by cuttings so there is no shortage of propagating stock. Green-wood cuttings taken in late summer readily took root after auxin treatment and vigorous young trees were obtained in a year or two. Cuttings taken from terminal as well as lateral branches are reported to develop equally into erect well-shaped trees.

In cultivation the trees seem to be free from any fungus disease. Few insects seem to attack them and although the ubiquitous Japanese beetle has been reported to do damage to the trees, we have not observed this adverse fact locally. Altogether the shapely form, the bright green feathery foliage which turns brownish yellow in fall, the ease and rapidity of growth, and its freedom from disease and pests, have already made this a popular ornamental tree. It may also prove to be of value as a timber or pulp tree. In any case *Metasequoia* seems to have become firmly established as one of the cultivated trees of mankind.

## Original Range and Habitat

In order successfully to grow a plant in a wide variety of localities and situations one requires first of all a knowledge of its original range and habitat. In the case of *Metasequoia,* there are available several papers on the subject based on first hand observations.

Early in 1948, Chaney made a hurried trip to the homeland of *Metasequoia* spending a few days in the field. Since it was winter, little could be observed or collected (Chaney 1948). In the summer of the same year, Cheng, together with Hwa and Chu, explored the area for several months and later Chu reported his observations in a joint paper with Cooper entitled "An ecological reconnaissance in the native home of *Metasequoia glyptostroboides*" (1950). This is the most detailed study of its kind. During the same summer, Gressitt also conducted an expedition to the region and spent considerable time in the field collecting primarily insect specimens. His travels and observations are reported in a paper published in 1953.

The first map showing the range of *Metasequoia* is given by Hu and Cheng (1948) in



Fig. 28. Another view of the Shui-sha Valley.



Fig. 29. A waterfall and a covered bridge in the Shui-sha Valley.

the paper which contains the original description of *M. glyptostroboides*. Chu and Cooper (1950) later gave a more detailed map showing its range. While Gressitt's paper does not contain a map, his account of his journey shows that the area covered by him is more extensive than Chu's. He actually discovered and observed many scattered specimens outside the range given by Chu. By carefully checking over Gressitt's itinerary and observations, it is found that the range needs extension southward beyond Lat. 31°, south of the city of Chung-lu. A revised map based on the original ones given by Hu and Cheng and Chu and Cooper and incorporating Gressitt's additional observations is given here (Fig. 26). The area of the original range of *Metasequoia* in this map is about one-third larger than that given by Chu and Cooper, estimated by them as covering 800 kilometers.

*Metasequoia* is found in West Central China, in the northwestern corner of Hupeh province, ranging at points slightly across the border of Szechuan province. It occurs primarily in the Shui-sha Valley, a narrow close depression at a relatively high elevation (700-1350 m.) in a sandstone region. The natural habitat of the tree is in shady and moist localities on slightly acid or circumneutral sandy soils. In this region the species occurs as a constituent of a presumably natural and actively reproducing forest community. (Figs. 27-30).



Fig. 30. Forested mountain slopes of the Shui-sha Valley. The tree in the foreground is a *Cryptomeria*.

The tree grows mainly in ravines from high up the mountain slopes down to the floor of the valley. It thrives best along the rocky banks of small streams and seepage grounds at the foot of the slopes forming dense thickets with other trees and shrubs. It is essentially a member of a stream-bank community. (Figs. 31 & 32). Moist soil and humid atmosphere seem to be essential for its successful reproduction. Seedlings are found in such moist localities. Gressitt reports that though the trees are generally erect, sometimes young individuals have widely spreading branches making them as broad as high, like yew trees in the valley.

The trees frequently associated with *Metasequoia* include three conifers, *Cunninghamia, Cephalotaxus Fortunei* and *Taxus,* and some thirty angiosperms including *Liquidambar formosana, Castanea Sequinii, Rhus spp., Cornus controversa,* and *Lindera glauca.* The commonest shrubs are species of *Spiraea, Hydrangea, Viburnum, Morus, Berberis* and many others. Woody climbers include *Hedera, Rosa, Parthenocissus, Akebia, Actinidia, Lonicera,* etc.



Fig. 31. A grove of *Metasequoia* trees.

It can thus be seen that the natural vegetation is primarily moist mesophytic and warm temperate in nature. No climatic data are available from the region, but observations of and comparisons with nearby areas show that it is a region of mild winters and hot summers, with the highest precipitation in spring and summer months. Frosts are probably infrequent and light. Chu and Cooper believe that a near climatic parallel in North America is the southeastern coastal plain, e.g., Georgia.



Fig. 32. A grove of *Metasequoia* trees.

### Cultivation in its Original Range

In its original center of distribution, the Shui-sha Valley, there has been considerable planting of *Metasequoia*. Seedlings and young trees are constantly being removed from native sites to be planted along the banks of the main stream in straight rows and along the margins of the rice paddies, along road-sides, and in home-yards. The tree, however, is of little economic importance there. It is planted for aesthetic purposes and is used only incidentally for fuel and in construction. The wood is not considered to be of good quality.

There is a prevalent local custom of periodically cutting the branches of *Metasequoia* as well as *Cunninghamia,* often almost to the top. Most of the trees outside the shady ravines have thus an extremely slender appearance, a straight trunk with new branches growing out laterally. (Fig. 33).

### Prospect in Cultivation

The rapid increase of popularity in the cultivation of *Metasequoia,* aside from deliberate dissemination and effective advertising, is due to its novelty and its intrinsic ornamental value. Because of the former it will always hold an indispensable position in any botanical garden, and because of the latter, it is now fast becoming a most desirable tree for public parks and private gardens all over the world. The ease of cultivation, rapid growth, and freedom from pests and diseases undobtedly greatly enhance its value as an ornamental tree.



Fig. 33. A *Metasequoia* tree planted near farm house by the side of rice fields. Note how the tree is closely cropped.

In addition to becoming a popular specimen tree in botanical gardens and on private lawns, *Metasequoia* seems to have further values as a useful cultivated tree. Being a deciduous conifer and generally of a narrow pyramidal shape, it can be used for lining avenues and walks. The lower branches can be trimmed off when planted along city streets or where space is at a premium. It may prove to be of comparable value to *Ginkgo,* now so extensively used for this purpose. The deciduous habit will enable it to withstand city atmospheric conditions which are usually injurious to evergreen conifers.

As the wood of *Metasequoia* is not considered of good quality, the tree is apparently not promising as a timber species but its rapid growth seems to indicate that it is potentially a desirable pulp tree for certain regions. Its actual rate of growth for a given area can of course only be determined by experimental studies, but its rapid growth as reported in many regions seems to indicate that it can be widely explored for this purpose. Another desirable attribute of *Metasequoia* is its monotypic nature, that is, it is the only species of a genus and has no close relatives. Since it is essentially free from insect pests or fungus diseases its introduction into a new region is therefore not likely to result in the introduction of new diseases which would constitute a threat to the native trees.

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# Trouble-Shooting Strategy

Patricia Allison

"What shall I do?" "Where shall I do it?" "When shall I do it?" If your search for disease and pest control information includes all three of these inquiries, you already have a fair concept of the basis of good control practices, for you are aware of the necessity of correct placement and timing as well as the correct method.

Successful control of diseases and pests results from the strategic intervention of man at crucial points in the cycles leading to destruction of the plants. What is crucial in one cycle may not necessarily be crucial in another, however. Clearly, one of the first objectives should be preventing the host and parasite pest from getting together in the first place. This is not always possible. Failing this, we usually attempt to prevent the build-up of large populations of damaging organisms and to minimize the damage once the host plant and its enemy have come together. How can we do these things? There are naturally three main avenues of attack: We can manipulate the host plants; we can manipulate the environment; and we can declare war against the pathogens and pests themselves. Your job as the gardener is made easier by the achievement of some of these goals by others before you ever purchase the plants and set them out. No matter what is done, or by whom, doing it at the right place at the right time is imperative.

## Keeping Plants and Their Pests Apart

The immigration of some plant pathogens and pests into an area in which the host is being cultivated can be prevented. The area can be large or small — large as a continent, small as a flower pot. Commonly this type of control can be exercised only with those pathogens and pests that would be initially distributed through man's activities anyway. True, they may be perfectly able to disseminate by other means once they have arrived, but the first step is the crucial one. And since man's activities can be regulated to some extent, legislation and its enforcement are among the techniques employed in preventing plants and their pests from getting together. It is difficult to do.

On a national basis, attempts are made to exclude from our country pests that are known to cause serious losses at their points of origin. Furthermore, attempts are made to exclude pests which might not be particularly damaging in their home grounds but which could very well create havoc in a new territory where hosts may be more susceptible, natural enemies absent, and environment more favorable. This means that some plant species cannot be shipped from certain parts of the world under any circumstances whatever for commercial use in the United States. Thus legislation and its enforcement protect your rose garden from one of its most destructive enemies, rose wilt, caused by a virus present only in Italy, Australia, and New Zealand. The same embargo, of course, protects American nurserymen from loss of their rose crops.

It is not possible to discern all potential enemies by inspection, even microscopic inspection, at ports of entry. Consequently many types of plants, apparently healthy ones included, must be planted out and observed carefully for two years by government inspectors before release for commercial use. Sometimes symptoms of disease cannot be observed in dormant stock arriving in this country and close observation during active growth is the only fair means of protecting both receivers and shippers.

Permission for distribution may be refused because plants carry with them stowaways that are not their own pathogens but are the pathogens of other crops. This often happens with propagative stock such as pips of lily-of-the-valley that were lifted from fields infested with the golden nematode of potato. Particles of soil clinging to the rootstocks harbor cysts of this pathogen that has caused enormous crop losses in Europe. So, regulation must extend to all types of plant introductions, and even to wrappings, boxes, and particles of soil on apparently bare roots.

In addition to embargoes and quarantines on a national scale, there are regulations restricting the movement of plants, soil, and farm machinery from state to state, or county to county. Unfortunately, the golden nematode did become established in one of our potato growing areas, Long Island, but interstate restrictions prohibit the further wanderings of this pathogen. Within states there are various statutes designed to protect nurserymen and consumers alike.

Keeping plants and their enemies apart is not the exclusive province of government agencies by any means. Individual nurserymen often establish their own "legislation" simply because it's good business. Thus the principal supplier of rooted chrysanthemum cuttings in the United States makes sure that all his stock harbors none of the main troubles of this plant. This method of control, keeping host and pathogen apart, can be used by growers themselves in the control of a number of pathogens, such as those that lurk in the soil. Any gardener who has had phlox die of Verticillium wilt or roses die of bacterial crown gall certainly shouldn't mix soil from those areas with soil in beds supporting healthy plants. Furthermore, when you insist on disease-free stock from your nurseryman, you prevent the introduction into your garden of many troubles that are among the most difficult to control thereafter.

There are other ways of keeping host and pest apart. An important one is controlling insect vectors — those insects that carry fungi, bacteria, or viruses with them to the host plants. This is extremely important, for example, in helping protect valuable plantings of elm from the Dutch elm fungus, and in protecting asters and other hosts from the virus causing aster yellows.

Keeping plants and pests apart is certainly not possible with all types of diseases and pests, and manipulating the environment is often impossible in utilizing this method of control. Who could command the winds to blow the billions of microscopic reproductive bodies of some fungi away from susceptible foliage? Who can command a mountain range or an ocean to appear between his crop and flying or wind-blown insects? No, only a fraction of the troubles of plants can be lessened by attempts to keep host and pest separated by space, and even these depend on correct location and timing of the attempts.

### Preventing the Build-up of Large Pest Populations

Enactment of laws or borderline interception do little to help if a pest has already been introduced and is well on the way toward becoming established and disseminated.

There is one measure that has proved worthwhile in some cases of record, however. That is the prompt eradication of all diseased host plants in the limited geographic areas of introduction before the natural methods of dissemination of pests have made such a program hopeless. Success of such attempts to reestablish a separation between host and pathogens is wholly dependent on early recognition of invasion and knowledge of the biology of the invaders. How hopeless were the attempts to eradicate Dutch elm disease and chestnut blight. How great are our losses as these magnificent trees disappear. How splendid was the victory, however, over citrus canker in Florida and Texas. Introduced in about 1911, recognized in 1913, eradication of this ruinous disease was begun as early as 1915 — a mobilization of forces whose timeliness is matched only by the arrival of ants at a picnic. Hundreds of workers toiled; hundreds of thousands of trees were removed from groves; millions of dollars were spent, but an industry remains intact, yielding more in a year than the total expense.

Total eradication is rarely possible, but there are many, many other ways that pest populations are limited, and here's where the work comes in. This is the battle we carry on day by day, season by season. Our strategies and weapons are as varied as the host plants we protect and as devious as their enemies we despise. Sometimes we lose, sometimes we win, but always a horde of hidden troops is battling at our sides. These allies are the "natural" antagonists of the pests we hope to conquer. Without them we probably would not have a ghost of a chance of maintaining ourselves and food crops, let alone the ornamental plantings that enrich our outlooks.

Recall that a single aphid egg in spring is the first of a season of a dozen or more generations, representing the potential of over a billion hungry little animals. Recall that a single successful microscopic fungus spore can give rise to a lesion on a plant in which a quarter of a million new spores are formed. Were each of these in turn successful, in ten days' time there could be some 62 billion more ready for action! This does not happen. Chief among the natural restrictions to pest populations is the non-living environment itself. Winds, rains, and animal vectors do not collect all spores and transport them directly to succulent host plants. Untold numbers are wafted to the upper air and die. Myriads of others are dashed to earth where they germinate to no avail. Countless others lodge on plants foreign to them. Many reach their host plant destinations alive, but because of improper temperature or improper humidity, or lack of liquid water, perish there just outside the storehouse door. And there are the luckless millions that never survive the rigors of winter or the parching heat of summer.

Those pests that can withstand the buffeting of their non-living environments are fair game to the rest of the living world. Insects gorge themselves on spores; diseases beset insects; fungi lasso nematodes; bacteria and viruses probably

afflict them all. Plant parasites and pests are even victims to their near relatives. Some fungi parasitize other fungi or poison their substrates; some insects destroy the young of other insects or lay their eggs in the bodies of other insects. Even stricken host plants themselves limit the reproductive potential of their own parasites. How many fungous or bacterial lesions can a leaf withstand without falling? Sometimes only one will cause it to die or break off. By perishing thus, so also do some of its pathogens. By early death of some plants, others may be protected from the massive onslaught of an overwhelming population of virulent pathogens.

It is the mighty minority, living on, surviving the dormant season, arriving at the host plant at the proper weather-time, at the proper susceptibility-place that we must do battle with. At times the tremendous curtailment by the environment of survival, reproductive capacity, and dissemination falls short and populations develop that are incomprehensible in numbers and destructive powers. These are set down as bitter embellishments of our history. Such was the dreadful potato famine in Ireland that resulted in death or immigration of 2½ million people. Such, too, was the near destruction of the French wine industry when production was reduced more than three-fourths by a fungus immigrant from the New World. Such, too, have been the ravages of the locusts, blackening many a summer sky as they have swept from field to field throughout our history.

These are national disasters. It happens also on smaller scales — in a county, on a farm, in a garden. It can happen when environment favors survival and development and when we, through our inactivity or carelessness, permit pests to take their tolls.

Most of the individual grower's control methods are population limiting methods, and most of these are protective measures rather than remedial measures. We try to keep plants healthy rather than cure them once the disease strikes. Again, we can use several approaches: directing an attack at the causal agents, altering the environment, and altering the host. Many techniques involve all three.

Successful attacks on causal agents are based on their habits and locations. Where does the pathogen overwinter? When does it resume activity? What part of the plant does it affect? How does it do its damage? All of these are important questions. Don't grab up a spray gun in blind panic and hope for the best. There are many things you can do to limit populations in addition to visiting that mysterious pesticide shelf at the garden store. Among the most important are sanitary practices in the garden and thoughtful planting schemes. Some of the principles learned in agriculture are also important at home. Limit populations by destroying their overwintering stages. Prune off egg masses of the tent caterpillar, for example. Many fungi, bacteria, and insects spend this season in or on dead plant parts. Collect and burn old rose leaves and spotted canes. The black spot fungus overwinters there and sends up showers of spores in spring. A giant step in disease control has been taken if this primary spore shower can be reduced. Remove dead tops of iris and tulips in fall and burn them. Sort out unhealthy bulbs and corms you may lift for the winter. Don't compost dead plant materials unless you *know* they are disease-and insect-free. It's a good idea to practice crop rotation too, changing the location of species in bulb and border plantings every few years. Be sure that you replant only healthy plant material, however.

Populations can also be reduced during the growing season and over winter by eliminating weed hosts. Many insects begin their season's activities in weed patches, and about the time their appetites are really whetted, move on to your favorite garden plants. Similarly, they may prolong their feasts in the fall on weeds. They may even carry viruses from weed hosts to garden hosts.

Eliminate alternate hosts when possible. If you like ornamental crab trees, don't develop a Juniperus passion unless you are prepared to baby both of them. The cedar-apple rust flourishes when both types of host are in the same vicinity. If the hosts are widely separated, the rust fungus can bother neither one of them, since it must pass a part of its life cycle on each, and one of the several types of spores formed just can't stand a long journey.

Exert some control on the environment, even the outdoor environment. Space plantings of zinnias, for instance, so that the lower leaves will not be shaded and crowded. This will help prevent such a rapid build-up of the powdery mildew fungus. In general, it's much better to water all your outdoor plants at ground level rather than by drenching the foliage in the process. Be sure that the soil is adequately drained in shady low spots so that the plants growing there won't be in a fog half the time.

Now about the matter of chemical sprays. Although acting at the surface of plants, they really are there to kill off as much of the attacking pest population as possible. Rarely is there one hundred per-cent success, but correct timing and complete coverage increase the percentage of kill of the attack force. Often during the skirmish

season, it is necessary to renew the application as new waves of pests approach. Altogether, the development of such chemicals to apply in the first place is a marvelous achievement. Just imagine what is attempted: Here we have living organisms, our valued plants. On the other side are other living organisms, the pests. In the middle we stand, also living organisms. Now, the basic, essential inner workings of us all are similar. We all utilize foods — fats, carbohydrates, proteins (the green plants making their own); we all utilize minerals; we all utilize oxygen; we all burn the food in one way or another and gain energy from it. Yet when we apply pest control chemicals to our plants we are reasonably confident that they *won't* kill the plants, that they *will* kill the *pests,* and that they *won't* kill us if we use them properly. This is called selective toxicity, and that last *if* is extremely important to us. This selective action is at its best at certain definite concentrations discovered during the research which resulted in the development of the chemicals. We must therefore be sure to follow directions absolutely, because too much may harm the plants, some more than others perhaps, and too much may also harm us. Always store the chemicals in a locked cabinet; always bear in mind your kinship to the whole living world when you use them.

Pest control chemicals are mainly protective. This means that they must be in place, all ready to affect the plant pests when they arrive. Here it is important to know something about the pest that causes the trouble. If it is an insect, it won't be very helpful to the plant to apply a fungicide. It will be helpful to you to get out into the fresh air and enjoy the exercise involved in the application, but in the meantime your adversary lives on, thumbing his nose, so to speak. So look for clues; the insects or pathogens themselves, webs or frass, the appearance of their damage. Your garden book on diseases and pests will be most helpful. Thanks to the broad-spectrum insecticides with high residual activity now on the market, it is not so important as it once was to know whether or not insect pests were chewing or sucking types, the one controlled by stomach poisons, the other by contact poisons. Thanks also to the interest of suppliers of pesticides in the home market, there are many preparations with combined ingredients to provide the maximum protection from the largest number of pests. It is important for example, not to allow one type of pest to multiply on a grandiose scale because you have unwittingly killed off its natural predators along with some types of plant pests. Thus mites can become cock-of-the-walk if DDT alone has been used in insect control. DDT has an exceedingly broad spectrum of activity, killing many types of insects, including the predators of the mighty mites.

Where is the correct place to apply these materials? Yes, here it is important to know something about the location of the pest. If the pale foliage or dieback of shrubs is due to the activities of fungi or insects working on the roots, it is foolish to cover the leaves with chemicals which can do no good. Similarly, since many disease fungi and insects do their work on the lower surfaces of leaves, the chemicals should be there when they begin.

When should they be applied? This will depend largely on the type of pest. You can rest assured, however, that when your ornamental plantings resume growth in spring their pests aren't going to remain dormant very long. The first important time to watch for damage, then, is early in the growing season. At the first signs of trouble, protect your plants. There are a good many ornamentals, such as roses and dogwoods, that should be protected from the word go without waiting for a sign of trouble, roses against black spot, of course, and dogwoods against borers. During the growing season keep close watch for any secondary build-ups of pests. In fall, when cleanup is so important, take stock of your pest control prowess. If you failed in some instances, your best defense the next spring may well be to attack the pest before it resumes activity. These dormant or delayed dormant sprays are important in control of many kinds of insects, among them hard-shelled scales and mites. General protective sprays later in the season have then only to reduce the small surviving population. Dormant sprays are also important when black spot has been severe in rose gardens to kill developing spores in spots on canes that cannot be pruned out.

At times the application period for chemicals may be dictated by the chemicals themselves. The soil fumigants as a group are damaging to plants. This means, then, that the soil to be treated for nematode control usually must be fallow, then treated, then aerated, then planted. Soil fungicides, although not as toxic as nematocides, are also most conveniently applied before or at planting time. Seed treatments are frequently directed at the pests in the soil that would harm the tender seedling as it emerges. The surrounding soil is thus treated when the seed is planted.

The big things about chemical control are these: recognize the existence of a problem; narrow down the cause; purchase the correct material; apply it correctly; apply it at the correct time; apply it as often as neccessary. An operator of one of the finest garden stores in this area reported recently that a customer did all of these

up to and including purchase of the correct material. Some time later however, the same customer complained because the material did nothing whatever to control his trouble — even though the package had been right out there in the garage all the time! The ancient Romans used to pay tribute to their rust god, Robigus, in order to limit plant disease. The garage shelf method is just about as effective.

### Minimizing Damage after Host and Enemy Are Together

With some crops it just isn't economically feasible to attempt eradication or chemical control. This can be because the crop and its pests are so widespread, or it can be because of the value of the crop and its method of cultivation. Controlling wheat rust by use of present day protective chemicals is theoretically possible, but never practiced. Thorough coverage and several applications would be necessary. Neither is possible on a practical basis. Forest trees present a somewhat similar problem. Application from the ground is virtually impossible. Applications from the air, at great expense, are successful in limiting some severe insect outbreaks but cannot be used routinely. What other courses are open? Damage can be minimized through long-term planning. Here the chief attack is through the host. Plants can be developed that just do not suffer as much as others from the attacks of their many enemies. Geneticists and plant breeders throughout the world work to include resistance to disease and insects among the valuable characteristics of their new varieties. This includes the development of resistant varieties of ornamentals and forest trees as well. There is great variation in susceptibility to diseases among varieties of such ornamentals as asters, carnations, chrysanthemums, gladiolus, tulips, and roses. Relative resistance to common diseases of roses, as a matter of fact, is one of the qualities considered in establishing the national numerical ratings of rose varieties.

Damage is also minimized by altering the host plant when we prune off diseased portions to prevent continued development of a pathogen.

The use of various chemicals is also becoming more important in limiting damage by pests once the pest and host plant come together. Here it is difficult to say whether we are manipulating the host or the pathogen, but the result is good and we will probably see many more materials in this field of "chemotherapy." Actually the object is to get something inside the host plant that will thwart pathogens when they attack. Thus there are compounds such as sodium selenate that can be applied to the soil around certain plants and successfully control some nematodes and even insects attacking the foliage. The insect, as it plunges its proboscis in for a meal, is poisoned by the chemical before damage becomes severe. These materials, then, act as internal protectants. Considerable research is in progress in this field to develop both fungicides and insecticides. Already there are some experimental ones, that when used as seed treatments for a certain crop, render the young seedlings resistant to a number of their common insect enemies for a period of several weeks.

Another group of chemicals acts slightly differently. They are not internal protectants, nor do they act in an exclusively protective fashion on the surface of plants. Rather they can penetrate leaf tissue and destroy young fungus growths already established there. Some mercurials and sulfurs are reported to act this way. Another chemical has the same type of role, but you do not know it as such. It's water — good, fresh water. This "fungicide" is frequently heated to a particular, highly critical temperature, then used as a dip for a particular, highly critical length of time with such plant parts as seeds, bulbs, corms, and root stocks. The object is to inactivate the internal pest, such as fungus or virus, without parboiling the host plant.

Manipulating the environment is also effective sometimes in reducing the damage of plant pests already in or near the host. Thus, abundant watering will sometimes minimize the symptoms caused by root-attacking insects, nematodes, or fungi. Similarly, proper fertilizing will aid in keeping whatever natural resistance a plant may have at a peak. Too much of one mineral element on the other hand, may increase susceptibility. This happens when a relative abundance of nitrogen causes much soft, leggy growth. Such tissue is more susceptible to various bacterial diseases. Of course, manipulating the environment is the most important method of attacking the other large category of plant troubles — the non-parasitic ones. These include mineral deficiencies, drought damage, acidity difficulties, and, oh yes, banging into your favorite tree with the lawn mower.

In another article we will talk about label reading and the characteristics of some of the commonest pesticides.

# Woody Plants Suitable for Circumneutral Soils

Edgar T. Wherry

There was published in this Bulletin several months ago[1] a list of woody plants which experience has shown thrive best in decidedly acid soils. Requests have subsequently been received for information as to species adapted to soils which prove on testing not to be acid, or in which the acidity has been neutralized by adding lime. The term circumneutral soil is applied here because under the climatic conditions of the eastern half of the United States, where most readers of this Bulletin have their gardens, soils never become markedly alkaline, but when acidity is reduced remain fairly close to neutrality.

Just as there is one major group of woody plants – the Heath Family – characteristic of acid soils, there is one including many ornamentals – the Rose Family – most members of which thrive best under circumneutral conditions. To it belong the horticulturally important genera *Cotoneaster, Crataegus, Malus, Prunus, Pyrus, Rosa, Rubus, Spiraea* and so on. Many members of the related Legume Family also favor circumneutral soils, although Black Locust *(Robinia Psendo-Acacia)* is tolerant of considerable acidity.

[1] Vol. 8 pp. 19-20, 1957.

Woody-plant genera in other families comprising many circumneutral soil species are:

| | | |
|---|---|---|
| *Abelia* | *Euonymus* | *Philadelphus* |
| *Aesculus* | *Forsythia* | *Platanus* |
| *Berberis* | *Hedera* | *Rhamnus* |
| *Buddleia* | *Hydrangea* | *Rhus* |
| *Buxus* | *Juglans* | *Syringa* |
| *Carya* | *Juniperus* | *Thuja* |
| *Clematis* | *Ligustrum* | *Tilia* |
| *Deutzia* | *Lonicera* | *Ulmus* |
| *Elaeagnus* | *Morus* | *Viburnum* |

While testing with indicators to ascertain if a given soil is acid or circumneutral is always desirable, there is one plant which will itself serve as an indicator – the Blue Hydrangea, (*Hydrangea macrophylla*). When grown in an acid soil, the flowers of this species show their blue color strikingly; but in a circumneutral soil they tend to become pink instead. One can indeed obtain both hues on the same bush: spread a few ounces of crushed limestone on the ground at one side, and of aluminum sulfate at the other. In the course of the season the effect of these substances in changing soil reaction will be made evident by contrasted flower coloration.

# The Handbook of Hollies

We are pleased to call the attention of our readers to the publication of the "Handbook of Hollies" which has recently appeared as Volume 36 of the National Horticultural Magazine. This superb contribution to the growing literature on an important group of ornamentals represents the combined efforts of members of the Holly Society of America, ably edited by Harry W. Dengler.

An introductory section contains an article on Holly Folklore and Legends, a general statement on the Hollies of the World, and detailed treatments of North American, Oriental and English Hollies. These regional accounts are provided with analytical keys as well as brief descriptions of individual species, varieties and cultivars.

Of considerable value to holly-growers is the section dealing with the Culture of Hollies. This includes articles by competent specialists on Planting, Pruning, Pests, Diseases, Propagating and Hybridizing.

A third, and final section, devoted to the Uses of Hollies, contains, among other things, chapters devoted to the use of hollies in landscape architecture, as hedges or screens, as topiary and bonsai subjects, and as cut material.

The Handbook, which consists of some 200 pages, is copiously and sumptuously illustrated with half-tones and line drawings. It may be obtained, at a cost of $3.00, from the American Horticultural Society, 1600 Bladensburg Road, Northeast, Washington 2, D. C.

J. M. F., Jr.

# Arboretum Activities

*(Continued from Page 48)*

Horticultural Society. His topic was, "Some Early Philadelphia Botanists." On November 18 he spoke to the West Chester Garden Club on the subject, "The Plant Ecology of Southeastern Pennsylvania" and on November 21 he gave an illustrated lecture to the Philadelphia Botanical Club entitled, "A Botanist in Southern Mexico."

On November 8 the Director and Miss Mary Milton, Propagator, represented the Arboretum at the annual meetings of the American Holly Society which were held at the Longwood Gardens. Miss Milton also attended the annual meetings of the Plant Propagator's Society in Cleveland, Ohio, November 21-23.

Dr. H. L. Li, Taxonomist, returned on November 23 from a three months' stay in England where, thanks to a National Science Foundation grant, he went to continue his studies on the trees and shrubs of Formosa. It is hoped that in a future issue of the Bulletin Dr. Li will favor us with an account of his experiences abroad.

### The Fernery

The task of replacing the glass roof of our tropical fern house has been completed and this attractive feature of the Arboretum's exhibits is once again open for inspection. The new roof is a monument to the ingenuity and painstaking workmanship of our builder, Mr. Thomas J. Carney, who designed and constructed it.

### Walks and Roadways

In line with our established policy of hard-surfacing additional sections of our walks and service roads each year, we have this autumn completed the task of surfacing the winding walk which leads from the Morris Mansion down to the Rose Garden. We have also surfaced several hundred feet of the roadway which leads through the Hawthorn and Lilac collections, turns south past the native Azalea planting and ascends the slope along the Germantown Avenue side of the Arboretum.

### Housecleaning

One of the ever-present problems in the maintenance of an Arboretum arises from the most natural of causes: namely, growth. As trees and shrubs continue to increase in size we are presented with the necessity of pruning, cutting back or, in some instances, actually cutting down, long-established specimens.

When two neighboring plants develop to the point where they threaten to crowd each other out of the picture, then a decision must be made as to which is the more valuable and should be retained, while the other, if it is too large to move, must be sacrificed.

For example, one of the rarest and most interesting plants in the Arboretum is the Chinese Dove tree, *Davidia involucrata,* which is to be found on the edge of the Swan Pond. During recent years this handsome specimen has become increasingly crowded by other trees growing next to it. It has been necessary to deal rather drastically with this situation in order to preserve a valuable plant and to show it off to the best advantage.

Another instance of the bad crowding of plant material was to be seen on the south slope below the Rose Garden. Here, in one of the oldest established plantings in the Arboretum, many man-hours have been spent this autumn in cutting out and pruning back a veritable jungle of vegetation. The result is the reopening of vistas long obscured and the showing to real advantage of many handsome specimens which had been all but hidden from sight.

### Plant Distribution

The annual distribution of plants to our Associates took place on Friday and Saturday, October 25 and 26. About 40 different species and varieties were arrayed on the porch of the Morris Mansion and more than 200 Associates took advantage of the opportunity to come and receive at least two plants of their own choosing.

In the September issue of the Bulletin Miss Milton invited an expression of opinion from our readers as to the time of year which they considered most favorable for our plant distribution. The response indicates that Spring appeals to many Associates in preference to Autumn. We shall therefore plan to hold our next Distribution Days in the Spring of 1959.

J. M. F., Jr.

# New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since March, 1957:

Mrs Jack Ackoff
Mr A. H. Alexander
Dr and Mrs Mark W. Allam
Mr and Mrs Donald K. Angell
Mr William Bandes
Mr Fred W. Bergman
Mr Benjamin Blackburn
Dr T. E. M. Boll
Mrs Willard Boothby, Jr.
Mr H. J. Brunkhorst
Mrs J. Ebert Butterworth
Dr J. J. Christensen
Mrs G. Dawson Coleman
Mrs Harry L. Curtis
Mrs Walter Darlington
Mr H. Hoffman Dolan
Mrs Paul Domville
Mr and Mrs Joseph N. DuBarry, IV
Mrs Addison S. Ellis
Dr Katherine O. Elsom
Mr Benjamin Eshleman
Mrs Brooks Evert
Mrs J. Howard French
Mrs Clinton W. Frontz
Lt. Colonel & Mrs Kenneth Gardner
Miss Marian K. Grace
Dr F. C. Grant
Mrs Harry W. Harrison
Mr and Mrs Edward N. Hay
Mrs Morgan Hebard
"Henry" c/o Col. Howard C. Fair
Mrs Charles E. Hodges Jr
Mrs J. P. Hollingsworth
Mrs James Hornor
Mr and Mrs Jacob Hossler
Mrs Willing Howard
Mrs Cortlandt Van Hubbard
Mrs Walter Jeffords
Mrs Lawrence Jewett
Mrs William A. Kelius
Mrs G. Walker Ketcham
Dr and Mrs Edward Krumbhaar
Mr David Lane
Mrs Edward Law
Mr and Mrs George A. Lear
Mrs Edward McCloskey
Mr Henry H. Meigs
Mr E. Matthew Miller
Mrs John W. Moffly, III
Mr and Mrs Royal F. Morris Jr
Mr George S. Munson
Mr and Mrs Charles Myers
Mrs A. E. Newbold
Mr and Mrs Otto J. Patzau
Mrs George W. Pepper, Jr
Mrs George W. Pepper, III
Mr George B. Peters
Mr B. L. Palmer, Rose Valley Nurseries
Mrs Henry Norris Platt
Mrs J. Nevin Pomeroy
Mr G. Gardner Richards
Mrs C. L. Ritchie
Mrs Richard M. Saul
Mr and Mrs Francis H. Scheetz
Mr Harold W. Scott
Mr C. Scott Seltzer
Mrs Howell Lewis Shay
Mrs Edward G. Shmidheiser
Mr A. McKnight Sykes
Mr Otto Stern, Stern's Nurseries
Mr John J. Stevens
Mrs O. J. Toland
Miss Elizabeth Trotter
Mrs Miles Valentine
Dr Paul A. Vatter
Mr W. Romine Wallace
Mr William H. S. Wells
Mr Warren F. Williams
Mrs Richard Worth
Mr Kenneth H. Yocom
Mr James E. McClellan
Dr and Mrs Donald Pillsbury
Mrs J. P. Sims

## LIBRARY ACCESSIONS

The following volumes have been added to the Arboretum Library during the last six months:

**Adventures in my Garden and Rock Garden,* L. B. Wilder (Doubleday, Page & Co., 1923)

***British Flora,* v. 1, W. J. Hooker (London, 1838)

*Cactaceas de Mexico,* H. Bravo (Mexico, 1937)

***Catalogue of North American Plants north of Mexico,* A. A. Heller (Lancaster, 1900)

*Compendio de la Flora Española,* 3 parts. B. Lazaro & Ibiza (Madrid, 1920)

*Encyclopedia of Annual and Perennial Garden Plants,* C. O. Booth (London, 1957)

***Enumeratio Plantarum,* 5 vols. C. S. Kunth (Stuttgart & Tubingen, 1833)

***Flora Barbiensis,* F. A. Scholler (Leipsic, 1775)

*Flora of British India,* 7 vols. J. D. Hooker (London, 1872)

*Flora of the District of Columbia and Vicinity,* A. S. Hitchcock, et al. (Washington, 1919)

*Flora of the Lancetilla Valley, Honduras,* P. C. Standley (Chicago, 1931)

*Flora Mexicana,* M. Sesse & J. M. Mocino (Mexico, 1894)

***Flora of New Mexico,* E. O. Wooton & P. C. Standley (Washington, 1919)

*Flora of the Panama Canal Zone,* P. C. Standley (Washington, 1928)

*Flore du Sénégal,* J. Berhaut (Dakar, 1954)

*Flora of Surinam,* A. Pulle (Amsterdam, 1953)

*Flora of Tropical East Africa,* W. B. Turrill & E. Milne-Redhead (London, 1952-54)

***Flora of Yucatan,* P. C. Standley (Chicago, 1930)

*Flore de la France,* 3 vols., H. Coste (Paris, 1937)

*Flower and the Bee,* John H. Lovell (Scribners, 1918)

***Handbook of the Flora of Philadelphia and Vicinity,* I. A. Keller & S. Brown (Philadelphia, 1905)

***Indigenous Trees of the Hawaiian Islands,* J. F. Rock (Honolulu, 1913)

***Insectivorous Plants,* C. R. Darwin (Appleton, 1875)

*Lilies of Eastern Asia,* E. H. Wilson (London, 1929)

***Manual of the Botany of the Northern U. S.,* Ed. 6, A. Gray (New York, 1890)

*Materia Medica Vegetabilis,* 3 vols. E. F. Steinmetz (Amsterdam, 1954)

*Notes on Useful Plants of Mexico,* J. N. Rose (Washington, 1899)

*Plant Propagation Practices,* J. S. Wells (Macmillan, 1955)

*Royal Botanic Garden, Calcutta, Anniversary Volume* (Calcutta, 1938)

***Student's Flora of Egypt,* V. Tackholm (Cairo, 1956)

*Sylva or a Discourse of Forest Trees,* J. Evelyn (London, 1679)

*Trees and Shrubs of Mexico,* 5 parts, P. C. Standley (Washington, 1920-26)

*Vascular Plants of the Pacific Northwest,* part 5, Compositae, C. L. Hitchcock, A. Cronquist, et al. (Seattle, 1955)

***Vascular Plants of S. Tomé,* A. W. Excell (London, 1944)

*Wayside Trees of Malaya,* 2 vols., E. J. H. Corner (Singapore, 1951)

*Gift of Dr. E. T. Wherry

**Gift of Philadelphia Academy of Natural Sciences

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# Publications by Members of the Staff

The following books by members of the Staff of the Morris Arboretum are available at reduced prices to Associates:

Wherry, E. T. *The Genus Phlox.* Morris Arboretum Monographs III. 174 pages. Illust. Philadelphia 1955. $4.00. Price to Associates, $3.00

Wherry, E. T. *Wild Flower Guide.* 202 pages. 106 plates. New York 1948. $3.50. Price to Associates, $3.00

Wherry, E. T. *Guide to Eastern Ferns.* 220 pages. Illust. Lancaster 1937. $2.00. Price to Associates, $1.50

Li, H. L. *Chinese Flower Arrangement.* 122 pages. 10 figs. 20 plates. Philadelphia 1956. $4.00. Price to Associates, $3.50

Fogg, J. M., Jr. *Weeds of Lawn and Garden.* 215 pages. 176 figs. Philadelphia 1945. $3.00. Price to Associates, $2.50

Please send orders and remittances to:

The Associates of the Morris Arboretum
The Morris Arboretum
9414 Meadowbrook Avenue
Philadelphia 18, Pa.

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*Salix babylonica*

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# Arboretum Activities

## Our Associates

As indicated on our masthead, the group of Associates of the Morris Arboretum is composed of people interested in supporting our manifold activities.

First created in the 1930's, this body of loyal friends made possible the appearance of the initial volume of our Bulletin, which was issued in 1935, and has supported its publication ever since.

For more than twenty years the number of our Associates remained between 80 and 90 and the annual dues were fixed at $10.00. In the Spring of 1955 there came into existence our Advisory Council under the able Chairmanship of Mrs. E. Florens Rivinus. One of the first matters to receive the attention of this Council was the desirability of increasing the number of Arboretum Associates. Each member of the Council sub-

*(Continued on Page 13)*

# The Weeping Willow and Lombardy Poplar

Hui-Lin Li

The Weeping Willow and Lombardy Poplar are two of the most widely planted trees in the world. In appearance, few trees show such extreme contrasts, broad, rounded, with drooping branches in one and narrow, pyramidal, with strongly fastigiate branches in the other. (See Cover and Figs. 1, 2, 4, and 5) [1]. Yet the two are closely related members of a distinct family, one being in the genus *Salix* and the other in *Populus,* the only two genera of the phylogenetically very much isolated family Salicaceae. Thus, in spite of their extreme outward differences, the two trees are near relatives, sharing between them a common genealogy and heritage.

The origins of cultivation of both trees are somewhat shrouded in mystery, and in a widely varying manner. The Weeping Willow, believed by Linnaeus and other earlier authors to be from Babylonia, is now quite definitely known to be a species of Chinese origin, cultivated since ancient times in that country but still growing wild in some parts, and carried from the East to the West in early historical times by human efforts. The Lombardy Poplar, on the other hand, is a man-made tree, most probably a selected stock from the common Black Poplar in Europe, and originated about some three hundred years ago. Its origin forecasts the great emphasis on clonal selection as an important phase of poplar culture now so extensively practiced in both Europe and America.

## The Willow Family

The Willow family is primarily restricted to the temperate regions of the Northern Hemisphere. It is readily distinguished from all other groups and constitutes the sole family of the order Salicales. The genus *Salix,* the willows, contains some 300 species and *Populus,* the poplars, some 40 species, but owing to frequent hybridization in nature, especially in the willows, their classification into species is an exceedingly difficult matter. Their identification is further complicated by the fact that the sexes of the trees are different, and their flowers usually appear before the leaves are developed.

The poplars can readily be distinguished from the willows, in addition to other technical characters, by their drooping male and female catkins, which in the willows are stiff and erect. The development of the catkins is associated with the fact that in the poplars, wind-pollination takes place while in the willows pollination is generally by insects.

The Japanese botanist Nakai, who proposed numerous new species, genera and families in his lifetime, once established a third genus *Chosenia,* referring to it a willow from Korea. This is *Salix bracteosa,* which differs from the other willows in its drooping male catkins, in its two almost free styles, and in its glandless flowers. Rehder (1940) and others have followed him in recognizing this anomalous species as representing a distinct genus. Extensive morphological studies made by Hjelmqvist (1948) and others show, however, that in spite of these more or less distinct characteristics, there exists a continuous series of transitions in other species that renders such a differentiation undesirable.

## Uses

The willows and poplars have been useful to mankind since prehistoric times. The use of willows for making baskets and containers, probably among the first articles manufactured by man, contributed much to the advance of our early culture in the formative period, and to this day the growing of basket willows is still an important industry in some parts of the Northern Hemisphere. The bark of some species is used for tanning or dyeing. As shade trees, both willows and poplars are invaluable because of their hardiness and rapid growth. As ornamental trees, like many other tree species possessing innate beauty, the most attractive kinds are indispensable for certain schemes of landscape decoration. The trees are also widely planted for windbreaks or screens or as holders of the soil. A few species are utilized locally for timber or for making charcoal.

## Diseases

One of the great advantages of growing willows and poplars is their rapid growth, but these fast growing trees are also prone to many diseases. Many species are susceptible to canker caused by bacteria, to canker and stem die-back caused by a number of fungi, and to certain leaf diseases caused by rusts. Susceptibility may be increased due to unsuitable growing conditions. Thus under certain unfavorable conditions, some of these diseases may wipe out an entire population.

Among the insect diseases, the more serious one is caused by the poplar or willow borer or

[1] We are indebted to Mr. Wm. Richard Carpenter for the cover illustration as well as Fig. 6, and to Dr. E. J. Schreiner for Figs. 4 and 5.

weevil, a beetle imported from Europe. This pest is causing extensive injuries, especially in the northeastern United States, to the basket willow industry and to many poplar and willow trees used for landscape planting.

## The Cultivated Willows

Willows have been cultivated in Europe and Asia since time immemorial for basket, timber, or for shade. The European species are mostly wide-spread in their natural ranges, occurring all the way to Western, Central or sometimes even to Eastern Asia. The cultivation of some apparently dates from prehistorical times and it is impossible to ascertain the exact localities where the different species were first grown.

Among the species cultivated specially for basketry work are the Almond-leaved Willow, *Salix amygdalina,* The Common Osier, *Salix viminalis,* the Purple Osier, *Salix purpurea,* and a form of the White Willow, *Salix alba* var. *tristis.* The most valuable timber trees of the genus are the Crack Willow, *Salix fragilis* and White Willow, *S. alba.* Other species like Bay Willow, *S. pentandra,* Goat Willow, *S. caprea,* Gray Willow, *S. cinerea* and Creeping Willow, *S. repens* are cultivated mainly for ornament.

In Eastern Asia, the most widely cultivated species are the Weeping Willow, *S. babylonica* and *S. Matsudana,* the latter in more northern regions and in wet as well as dry localities. Other species are cultivated mostly in local areas.

Many of the European species were introduced into America in colonial times and quite a number of these have escaped into the wild in the eastern states and have become naturalized. The native American species did not begin to be cultivated until about the beginning of the eighteenth century. Among the better known and early grown species are Pussy Willow, *S. discolor,* and Silky Willow, *S. sericea* of the northeast, and Black Willow, *S. nigra* of wider range. The native Basket Willow, *S. petiolaris* is cultivated in the northeast for making baskets along with the introduced Osiers, *S. viminalis* and *S. purpurea.*

## The Cultivated Poplars

Many species of poplars have been cultivated in the Old World since very ancient times. Of European and Western Asiatic origin are such common species as the White Poplar, *P. alba,* Gray Poplar, *P. canescens,* European Aspen, *P. tremula,* and Black Poplar, *P. nigra.* Of Eastern Asiatic origin are the Chinese White Poplar, *P. tomentosa* and Chinese Aspen, *P. adenophora.* Of African and Asiatic origin is *P. euphratica,* the original "Weeping Willow" of the ancient scripts.



Fig. 1. The Weeping Willow

The association of sadness with poplars seems to have originated early both in the East and the West. It probably alludes to the captivity of the children of Israel "by the rivers of Babylon." Lombardy Poplar is often used in graveyards in the place of cypress in some countries of Europe and the Near East. In China, the poplar has been considered since the most ancient times as one of the five official memorial trees, the one reserved for the graves of the common people.

The most commonly cultivated American species is the Cottonwood, *P. deltoides* of eastern North America. The tree is very variable and runs into many forms and varieties. In North America it was apparently first cultivated in the first half of the eighteenth century or earlier. It is now the most generally planted tree in the middle States. It was introduced into Europe around 1750, and the first description of it was published in 1755 by Duhamel, who extolled its value for the decoration of parks (Sargent 1896). In Europe, it is generally planted as a timber tree and is the most widely cultivated species of American poplars. There it hybridizes with the European Black Poplar, giving rise to numerous hybrid poplars known as *P.* × *canadensis,* widely used in reforestation work.

Among the more recent introductions from eastern Asia are some highly ornamental species. Some of these are wild, others have long been cultivated there and were first introduced into the West toward the latter part of the nineteenth century. Among the more notable is *P. Maximowiczii,* from northeastern Asia and Japan, a handsome poplar with striking bark and foliage. The bark of old trunks is gray and deeply fissured. The leaves are large, dark green on the upper surface and whitish on the lower. Another handsome species is *P. Simonii* from northern China, a tree with slender branches and rather small bright green leaves. There is a variety 'Fastigiata' of narrow pyramidal form with upright branches. (Fig. 3).

## The Weeping Willow

The Weeping Willow, *S. babylonica,* has a confused history in the literature. The name "Willow of Babylon" was mistakenly bestowed on this tree, which is quite definitely of exclusively Chinese origin. The willows mentioned in Psalms growing by the rivers of Babylon are now known to be not willows at all but a poplar, *Populus euphratica.*

In China the Weeping Willow is a favorite garden tree and has been widely planted from time immemorial. It now occurs nearly all over the country, especially along the waters on alluvial areas. As it is extensively planted, it is difficult to tell the wild from the cultivated trees. In Western China, in the mountainous region on the upper reaches of the Yangtze River, it is apparently still growing wild, and there trees attaining to the largest size are to be found (Wilson 1920).

From the most ancient times, the Weeping Willow has been closely associated with the Chinese people, playing an integral part in their garden art, folklore, painting and literature. The slender twig swaying freely in the wind is compared in the traditional literature with a dancing figure, hence the common term "willow waist." The weaving branches also symbolize affection and attachment, and willows were at former times picked to give to a departing friend to signify unbroken friendship. The willow tree is an indispensable item in the rock garden, always planted by the side of the pond which usually is the main feature of the design. It is widely known in the West by the "willow pattern" porcelain which is to this day still quite popular.

The Weeping Willow does not grow well in colder countries especially in drier situations. The willow that takes its place in northern China, around Peking, for instance, is *S. Matsudana.* A pendulous form, especially planted for ornamental purposes, resembles closely the Weeping Willow in general appearance. Other local species are similarly used in Korea, Formosa and other areas in eastern Asia.

## Dispersion of the Weeping Willow

The Weeping Willow was introduced from China into Japan in early times and is now commonly planted there in gardens and used also as a street tree. The tree cultivated there is the male form and from there it has also been introduced into California and commonly planted around San Francisco (Wilson 1920).

The spread of the Weeping Willow toward the West, into Central Asia, must have happened at a very early date but nothing is known definitely. Most probably it was carried westward by travelers along the overland "silk road" through the deserts, either deliberately or accidentally. As willow branches were used extensively in former times for weaving baskets, crates and for many other purposes as well, and as the twigs are easily rooted by mere insertion into the ground, incidental introduction and cultivation in many lands could have happened readily and repeatedly.

As mentioned above, the tree introduced into Japan is male while the one introduced into Europe is female. In China both male and female trees are common. The downy seeds, known as "willow downs," flying in the air in late spring, are a familiar sight in regions where willows are abundant and a frequent subject in poetry.

The Weeping Willow was not known in western Europe until around 1700, at a time when the direct sea route to China was already quite active. However, the first introduction of the tree seems not to have come by sea but indirectly from Western Asia, a fact which shows that the species must have been well established in Central and Western Asia at a much earlier date.

The Englishman James Petiver, in his work "Musei petivertiani centuriae. . ." published in 1703, mentioned that a specimen collected by Cunningham from China has pendulous branches and bears the Chinese name Yang-liu (Bretschneider 1882-1895). Cunningham went



Fig. 2. The Weeping Willow in early spring, Morris Arboretum.



Fig. 3. *Populus Simonii* 'Fastigiata'.

to China by sea in 1698. This shows that the tree must have been unknown to England in cultivation at that time.

A later record of the tree is found in Tournefort's "Corolarium" of 1719, which describes the tree as the Oriental Willow, as found in the Levant. The tree must have been finally introduced into England sometime before 1730 for it was known to be on sale in gardens near London as stated in a catalogue published by Philip Miller in that year (Wilson 1920).

According to Wilson, since the Weeping Willows in Europe are female they are in all probability originated from a single tree introduced either by Tournefort or Wheeler from Western Asia. The latter mentions a tree which might have been a Weeping Willow in his book "Journey in Greece and Asia Minor" published in 1682, but this record is even more uncertain.

Although Wilson asserts that the tree was probably introduced into England indirectly from Western Asia, it seems also highly probable that it could have arrived directly from China by sea in the late fifteenth or early sixteenth centuries. The fact that all European trees are female makes Wilson's contention that they are all descendants of a single tree also feasible, but again more than one clone[2] might have been involved.

From Europe the Weeping Willow was carried to many other parts of the world including North and South America. It is not known when it was brought to the United States but Wilson thinks it was probably toward the end of the eighteenth century.

The most famous of these cultivatd trees is probably one of the many planted on St. Helena by Governor Beatson about 1810, one which became a favorite with Napoleon then in exile, under which he used to sit at length meditating on his past glories and vanities.

### The Weeping Willow in Cultivation

The Weeping Willow, like other species of the family, is fast-growing but short-lived. It is widely cultivated for its distinct ornamental effect but aged or very large specimens are not common in cultivation. It is also not hardy in very cold climates.

The willows hybridize freely in nature. The female trees of the Weeping Willow, as cultivated in the West, have produced in the nineteenth century several hybrids or supposed hybrids with some other species, and these hybrids



Fig. 4. *Salix* × *elegantissima.*

[2] The term "clone" is a technical one now used for all plants propagated vegetatively from a single individual.



Fig. 5. Poplar trees in the neighborhood of the town of Monoclaieri, Turin, Italy, after a water-color by Gieuseppe Pietro Bagetti, 1764-1831.

have since been maintained by vegetative propagation. These trees resemble somewhat the Weeping Willow in general appearance especially in the long hanging branches but are usually more hardy and are thus often planted where the Weeping Willow proves to be tender.

Two of these trees are supposed hybrids between the Weeping Willow and the Crack Willow, *Salix fragilis* of Europe and Western Asia. One of them is called *S.* × *elegantissima,* the Thurlow Weeping Willow, (Fig. 4) and the other *S.* × *blanda,* the so-called Wisconsin Weeping Willow. A third tree is a putative hybrid between the Weeping Willow and *S. alba,* the common White Willow of the Old World, and is named *S.* × *sepulcralis.*

### The Origin of the Lombardy Poplar

The Lombardy Poplar, ever since it was first known, has been a problem to botanists and horticulturists. The tree, as compared with the Weeping Willow, has a much shorter history, as it apparently first appeared only some three hundred years ago, but its origin is even more mystifying than the Weeping Willow.

The Lombardy Poplar first originated as a cultivated tree in Europe. It was a tree unknown to the ancients. It was not recorded by Pliny, who certainly would have taken notice if it existed then.

The earliest cultivated trees seemed to come from northern Italy, where the Black Poplar is common, particularly in Lombardy, on the banks of the Po, hence the name Lombardy Poplar or Po Poplar. (Fig. 5) . The Italians generally called the tree Cypress Poplar, Pioppo Cypresso, on account of its shape.

Manetti noted in 1836 as cited by Loudon (1838) that along the banks of the Po, there were Lombardy Poplars growing among the Black Poplar, *P. nigra.* As these appeared on exposed banks once overflowed, he believed the seeds were buried in the soil for many years and came from extinct forests. This seems hardly likely, and as noted by Loudon, it would be more plausible to consider these as seeds of the current year carried there by the wind. Manetti's letter, apparently a translation from the Italian, is the only reliable record of this tree made on the basis of first-hand observation at this early date. It was reprinted in the Gardener's Chronicle in 1883, but as the anonymous author notes therein, "it is very contradictory and vague in some parts."

The Lombardy Poplar is considered by some earlier authors as native to Persia and the Himalayan region and probably carried from there to Italy (Loudon, 1838; Anonymous, 1883) , but there does not seem to be evidence to substantiate these views. Because of the fact that it was not introduced into Tuscany till 1805, Loudon believes that it is not indigenous to Lombardy or any part of Italy as he thinks it certainly could not escape the notice of the Roman agricultural writers.

All evidence seems to indicate that the Lombardy Poplar first made its appearance in the Po Valley of Italy. The enigma which confronted Loudon can be explained if we assume that it did not exist in ancient times, but appeared, some three hundred years ago, as mutants of the Black Poplar. Its remarkable shape accounts for its selection and cultivation by some enterprising farmers and its subsequent dispersion to other countries.

That the Lombardy Poplar is closely related to the Black Poplar was a fact very early noted by botanists. It was first considered by Munchhausen as *P. nigra* var. *italica* (1770) ; later as a

distinct species under such names as *P. italica* Moench 1785, *P. dilatata* Aiton 1789, *P. pyramidata* Moench 1785, and *P. fastigiata* Desfontaines 1804. However, the closeness of the two in vegetative as well as reproductive structures leaves little doubt that the Lombardy Poplar is, in spite of different growth form, only a variation of the common Black Poplar of Europe.

This seems to be the generally accepted view at the present. In a recent monograph on poplars by Hesmer (1951), it is called *P. nigra* var. *italica*. As this tree represents a form selected for cultivation, the modern terminology renders it as *P. nigra* cv. 'Italica' and it is so named in another recent monograph issued by the FAO (1956).

## The Dispersion of the Lombardy Poplar

From Italy, the Lombardy Poplar was introduced into France in 1749 and at about the same time also into Germany (Loudon 1838). It was introduced into England at about 1758 from Turin (Aiton 1789). Since then it has been generally planted throughout Europe, either as a roadside or ornamental tree, or occasionally as a timber tree. The date of its introduction into America is given as 1784 by Sargent (1896). During the nineteenth century, the tree was taken to other parts of the world from Europe or America. It is now very commonly cultivated in Eastern Asia, as a street or shade tree or for reforestation purposes.



Fig. 6. Lombardy Poplars in New York State.

## The Lombardy Poplar in Cultivation

The Lombardy Poplar is now one of the most widely planted trees around the world, but nearly all planted trees are male ones. (Fig. 6 and 7). Only a few female trees are known to exist, and these have less strictly upright branches and consequently forming a broader head. The occurrence of both male and female trees shows a number of clones are involved.

In cultivation, there is another fastigiate form of the Black Poplar, cv. 'Plantierensis', very similar in habit to the Lombardy Poplar but usually not so slender. This resembles closely the Lombardy Poplar and is generally also called by that name. It differs, however, in the hairy branches and leaf-stalks, and for this reason, it is supposed to be a cross between cv. 'Betulifolia', Dawny Black Poplar and the true Lombardy Poplar. This tree originated at Plantieres, in France, in about 1885 or earlier, and both male and female plants are known.

The main value of the Lombardy Poplar is ornamental. The distinct fastigiate shape is often exploited with admirable effect in landscaping to contrast with horizontal lines of architecture and with round-headed trees. It often fits in the landscape to balance horizontal lines like bridges or walls, or certain types of buildings. Its taller, pointed heads give contrast to the round heads of most other trees.

The Lombardy Poplar, like other species of poplars, is subject to many diseases. It is generally resistant to bacterial canker and seems to be fairly resistant to rust. However, the trees, especially the older ones, suffer rather violent die-back due to some as yet unknown cause. This die-back is fairly common in European trees and was especially prevalent some eighty years ago, but it is now of more frequent occurrence in North America.

This diseased condition was formerly believed by some as a decline in vigor due to clonal senescence (Focke 1883). But as the European trees are now in an apparently better condition than before the turn of the century, evidently this is not the case. More probably, in the Lombardy Poplar, a number of clones were actually represented, and as the more susceptible ones had been killed and eliminated, the surviving ones are among the more resistant.

The prevalence of this destructive disease makes this tree unpopular in North America. Attempts to introduce from Europe certain resistant clones should be made in order to revive the Lombardy Poplar populations in America.



Fig. 7. Lombardy Poplars along highway in Ontario, Canada (Canadian Government Travel Bureau photo).

## Breeding and Selection of Poplars

In recent years, great efforts have been made in Europe as well as in the United States in the promotion of research and culture of poplars. The improvement of poplars is aimed especially at the production of fast-growing, disease-resistant strains. The technique includes primarily hybridization and clonal selection. (Pauley 1949, Schreiner).

The native species of poplars have been used for centuries in all parts of Europe. Hybrid poplar culture was first started there about 200 years ago when the American Cottonwood was introduced. Countless numbers of hybrids have since been produced by natural hybridization between the introduced American species and the native European Black Poplar, followed by back-crosses between the hybrids and the latter species.

Many of these hybrids or putative hybrids are superior to either one of the parental species in rate of growth, disease resistance, stem form or other desirable characteristics. As these poplars can be readily propagated by cuttings, superior individual trees can be selected and propagated.

The most important hybrid poplars are crosses between the American Cottonwood, *P. deltoides* and the European Black Poplar, *P. nigra,* known collectively as *P.* × *canadensis.* These hybrids were probably originated first in France before 1750, and there are now many different forms, named and unnamed, propagated as clones. These were originated independently in different places between the various forms of the two parent species.

The culture of poplars is now continued on a more scientific basis. Instead of selecting from spontaneous hybrids, controlled breeding is now performed and clones are selected and propagated from the resulted hybrids bearing desirable characteristics.

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# The Pesticide Choice

Patricia Allison

The colorful conglomeration of chemicals at the garden store is easily one of the most bewildering sights to the conscientious gardener who has recognized that he has a pest problem and wants to do something about it. There he stands, ready to purchase the correct material so that he can apply it correctly, at the right time, and as often as necessary. But which of the many preparations before him is the correct material?

Lucky for him that his garden store does not stock all of the pesticides on the market, for the choice would seem even more difficult! For example, each year Dr. Donald Frear of Pennsylvania State University, an expert in the field, compiles a list of pesticide products. There are over 5000 listings of fungicides and insecticides alone! Is only one of these thousands "THE correct purchase" for the gardener standing before the shelves in the store? No. Many will do the job. Confusing as some of the names are, the problem of selection is not nearly as difficult as many believe. Let's consider first how there came to be so many products to choose from.

## Life History of a Pesticide

The modern pesticides perform modern "miracles" and are put on the market only after the expenditure of modern millions. These chemicals are designed to kill living organisms such as fungi, bacteria, insects and nematodes. But this is not all. They must do it without harming other living organisms, such as the plants harboring the pests, and such as the man wielding the spray gun. The attainment of these objectives is possible only through prolonged research. Furthermore, the claims made by the manufacturers on the labels are not merely claims. They are backed by research data and must satisfy the most careful scrutiny of government experts whose principal interest is the safe use of the material.

It is a long, long road from the gleam in the chemist's eye to the ring of the cash register. These are some of the sign posts along the way: After the first sample of new chemical has been synthesized and turned over to staff entomologists and pathologists, it is repeatedly tested in the laboratory against an assortment of pests. If found to be harmless to the plants, and if it once more controls the pests, additional testing must be undertaken. (By this time the eye-gleam has been transferred to the patent department). The additional tests involve first small, then large-scale fields experiments at many locations.

Before such a program can get underway, three new lines of investigation must be initiated. 1) Data must be collected concerning its possible harmful effects on mammals. 2) Ways must be found to manufacture the chemical in larger test quantities. 3) Ways must be found to formulate the chemical effectively.

Mammalian toxicity tests are expensive, time-consuming procedures to gain essential information about the safety of the potential pesticide to the users and other beneficial animals. The effects on animals of large single doses and of small doses supplied over a long period are studied.

The development of ways to make larger batches of the candidate pesticide results from the combined ingenuity of chemists, chemical engineers, and cost experts.

The third line of investigation is equally important and has direct bearing on your choice of material from the shelf at the garden store. Up to this point we have been talking about a relatively pure chemical—quite unlike the products you buy. The investigators have had to use special techniques in applying the material to plants. Now that the chemical shows such promise, ways must be found to put this active ingredient into such form that it can be marketed and can be taken from the package and put to use easily by the purchaser.

Active ingredients are very potent. In actual use, only minute quantities are applied to each plant. There must be some means to assure that this small quantity is evenly distributed. This is accomplished by dilution with some other material so that the combined bulk can be handled conveniently and accurately. This is called formulating, and the products you buy are *formulations of active ingredients.* With *spray* formulations most of the diluting of the active ingredient is done by the consumer when he adds water. With *dust* formulations the dilution is with some dry, non-caking powder, and is done by the manufacturer. Thus the consumer buys a greater bulk of "inert" ingredients when he buys dusts than when he buys spray materials. The "inert" materials in spray formulations consist of small amounts of wetting agents, stickers, and other materials that help make an acceptable final suspension of the active ingredient when water is added. You can buy spray formulations as dry

"wettable powders" or as liquid "emulsifiable concentrates." Dust formulations may also contain small quantities of various compounds so that they will have the correct properties for most effective performance of the active ingredient at the plant surface.

In the development of a new pesticide, all of the trial formulations must be carefully tested to be sure that the potency of the active ingredient has not been diminished by combining it with other compounds. When satisfactory ones are found, the field testing really begins. This may take several years, and is performed largely by state and federal agencies under carefully controlled conditions. If the pesticide still looks good, the federal government may approve its commercial use for specific crops. Approval is given only after careful examination of data concerning its effectiveness and safety. Even then testing is not complete. Whether or not the pesticide can be combined with other pesticides is very important. New fungicides, for example, must be compatible with many of the insecticides in use, so that both types of materials can be applied at the same time. Sometimes the grower mixes the pesticides himself; sometimes they are already combined by the manufacturer.

You may have guessed by now that those 5000 listings of pesticides are not listings of 5000 different active ingredients at all. They are various formulations and combinations of a relatively few potent chemicals made up for sale by a large number of companies under an even larger number of brand names. For this reason alone it becomes imperative to read the labels before buying, and to distinguish between brand names and active ingredient names. You can rest assured that the brand names are going to be in big, colorful letters, and that the active ingredients are listed at the bottom somewhere in fine print. The size of the letters is made up for by the size of the words, however. For example, a common ingredient is 2,2-bis (p-methoxyphenyl) 1,1,1-trichloroethane. Another is N-trichloromethylmercapto-4-cyclohexene-1, 2 - dicarboximide. Pretty terrible. Because these chemical names are so unwieldy for easy use even among entomologists, "coined names," referring to specific active ingredients such as the examples above, have been approved. The coined names for the insecticide and fungicide just mentioned are methoxychlor and captan, respectively. They are much easier to remember and their use in recommendations for pest control does not imply the use of any particular brand. The books listed below will tell you exactly what the chemical names are that correspond to the coined names. Most labels now list coined names.

## General Categories of Pesticides

The most fundamental characteristic on which to base a grouping of the many garden pesticides available to you is, of course, their killing power. Thus there are insecticides, miticides, fungicides, bactericides, and nematocides, all named after their victims. The insecticides have little or no fungicidal activity, and vice versa. Furthermore, there are various combinations of these basic types of active ingredients. Mixtures containing several insecticides or insecticides and miticides are common. Some "all purpose" formulations contain one or more insecticides, a miticide, and a fungicide or two. Your choice of material will depend in large part on the extent of your knowledge of what pest problems you are likely to encounter in your garden. You should be fully prepared to wage war before the growing season begins. If you are not sure that you will be able to distinguish fungus difficulties from insect damage, the best move would be to get a good all-purpose preparation. If you can distinguish the two, investing in a combination insecticide-miticide, and a good fungicide would be better, as you are likely to need the insecticide more often than the fungicide on most plants (Roses not included!). If you are becoming skillful in differentiating insect from mite or red spider damage, purchasing separate preparations for them could be advised. Many gardeners find that a good bit of their fun is derived from mixing their own combinations. Dr. A. W. Dimock of Cornell recommends a good homemix, that would be superior to most ready made preparations.

The pesticides at the garden store can be further classified on the basis of type of formulation. Here again, many of the preparations can be eliminated from consideration after you make a single decision. That decision is whether to spray or to dust. There are advantages to each. Assuming that the job is done regularly, the spray job is better. Spraying involves a capital investment in applicator somewhat above that for a duster. It also involves mixing up the pesticides to begin with and cleaning the apparatus after use. But the sprayer is much more versatile than the duster from three important standpoints. 1) You can make your own mixes, omitting some ingredients when they are not necessary. 2) Some plants require ingredients that others do not. It is a simple matter to mix a tankful for them. This allows you to take advantage of the specific recommendations written up especially for you in garden reference books. 3) Spray from a good sprayer can reach parts of plants inaccessible with a duster. (Extra dividend to spraying: Pumping up a sprayer will

help that waist-line.) Dusting, on the other hand, might be more convenient from the application standpoint and thus lead to more regular application. Cost of the pesticides during the season will be higher, and considerable care must be taken to avoid windy periods for applying the dusts. Also emptying and refilling a duster can be messy.

There is a third group of materials, the so-called all purpose "spray *or* dust" mixtures. It stands to reason that when the active ingredients have been diluted enough by a dry carrier to use as a dust, you will have to use a relatively large amount in making up a spray. When this is done the treated plants are apt to be unsightly with the accumulated carrier applied wet. Zineb, for example, one of the best all-around fungicides, is supplied as a 65 per cent wettable powder for spray use. One tablespoon per gallon of water is sufficient. When formulated as a dust, commonly a concentration of 6.5 per cent in the dry carrier is puffed onto the plants. Now, if this same concentration is in a "spray or dust" mixture, you must use 10 tablespoons per gallon of water! It's better to use mixtures designed especially for spray use.

There are three other categories of garden pesticides that should be mentioned. One is the group of formulations now available to you for control of insects in the soil. Take advantage of the opportunities to control grubs, ants, chinch bugs, cutworms and the like. Another group of preparations is for use as seed treatments. In general, small seedlings are much more susceptible to killing by certain soil fungi than are mature plants. A small packet of one of these powders will treat hundreds of seeds.

The third category of pesticides is one that should interest you right now. These are the potent "dormant" sprays and dusts. They are compounds such as lime-sulfur, oils, and dinitro chemicals that can be applied at high concentration to plants before the buds have broken, but must be used at low concentration or not at all after foliage is exposed. This dormant spray can be an extremely important event in your garden schedule, because some of the most serious insect pests, as scales, mites, and aphids can be much reduced in number as a result of this one application. Lime-sulfur and the dinitro compounds also help to reduce the amounts of some fungi that have overwintered on twigs and buds. The dormant sprays should be applied on a day when the temperature will be no lower than 40 to 45 degrees. If you use lime-sulfur, don't forget that spray drift will ruin white paint.

While you're thinking about mobilizing your forces, take a tour of your favorite supply store and ask to see the sprayers and dusters. While you're there you can practice your label reading.

Look for:

1) Whether spray or dust.
2) Name of active ingredient and concentration. Do not buy if this is not present.
3) List of pests it will control.
4) Names of plants the chemical might harm.
5) Instructions for use. Some chemicals, as sulfur may be harmful in very hot weather. Others may be inactive or harmful in cool weather.
6) Safety precautions.

Now is also the time to purchase a book on garden troubles. Three of the best are listed below. They are recent enough to contain discussions of most of the new pesticides. In them you will find explicit recommendations for particular troubles, and helpful suggestions for all around protection. After a session with your new source of help, make a second trip to the store, stock up on the ammunition you will need, and plan your attack!


Dimock, A. W. 1953. *The Gardener's ABC of Pest and Disease*. 191 pp. M. Barrows and Company, Inc., 425 Fourth Avenue, New York 16, N. Y.

Pirone, P. P. 1952. *Modern Gardening*. 371 pp. Simon and Schuster, 630 Fifth Avenue, New York 20, N. Y.

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# Local Chapter of Rhododendron Society

The Arboretum is happy to announce the organization of a Philadelphia Chapter of the American Rhododendron Society. The President of the new Chapter, Mrs. William Kelius of Levittown, realized the need for a more centrally located meeting place for the many Rhododendron enthusiasts in the Philadelphia area, and it is largely due to her efforts and keen interest that the Chapter was organized.

Seventeen people attended the first meeting held in December, and since that time the membership has increased to 51. The group will continue to meet at the Arboretum at 8:00 P.M. the second Thursday of the months of April, May, and June. Meetings will not be held during the summer months but in September the Arboretum will again serve as the meeting place for this rapidly growing group.

The Chapter will arrange monthly programs to include talks by several Rhododendron authorities and field trips will be made to some of the private gardens in the area. For more extensive field trips, the Chapter will cooperate with the very active Middle Atlantic Chapter of the American Society.

Annual dues, which include free attendance at the monthly meetings plus receipt of the Quarterly Bulletin of the American Society, is $5.00. Those who are members of the American Society and are not affiliated with a local chapter may join the Philadelphia Chapter simply by indicating their intention to the American Society headquarters in Portland. Those who are now members of a local chapter may join the Philadelphia Chapter by paying $1.50 dues and still retain full membership in any other local chapter.

Persons interested in joining the Philadelphia Chapter may communicate with Miss Mary Milton, Secretary, at the Morris Arboretum, or Mrs. William Kelius, 67 Spineythorn Road, Levittown, Pennsylvania.

M. M.

# Arboretum Activities

*(Continued from Page 2)*

mitted a list of persons who it was believed would like to be affiliated with the work of the Arboretum. At the same time it was decided to create four classes of memberships with annual dues ranging from $5.00 to $100.00.

Special invitations were printed and circulated among the lists of names submitted by members of the Council, as well as by members of our own staff. The results of this rather modest "campaign" have been most gratifying, as is evidenced by the fact that early in February of this year we passed the 500 mark!

The benefits of membership are several: Our Associates receive the quarterly Bulletin free of charge and are entitled to purchase other publications at a reduced cost; they enjoy full library privileges with the freedom to borrow books and periodicals; they may receive expert advice and assistance with their horticulture problems; they are invited to attend lectures and other events scheduled at the Arboretum; and they participate in the annual distribution of unusual trees and shrubs.

If any of our readers have friends who they feel would be interested in becoming Associates, we shall be grateful if they will bring their names to our attention.

## Seed Exchange

One of the ways by which the arboreta and botanical gardens of the world help to build up each other's living collections is through an exchange of seeds. If institutions are near enough and transportation problems are simple, they may also exchange bulbs, scions, rooted cuttings and entire plants, but packets of seeds are by far the most effective medium of exchange.

Each Autumn members of the Arboretum staff devote many hours to the collection of seeds of trees and shrubs which we believe will be of interest to other institutions throughout the world. Consideration is also given to the native woody flora. For example, last September Mr. Richard B. Chillas, Jr., one of our Associates, made many trips throughout southern New Jersey and southeastern Pennsylvania, collecting seeds of wild trees, shrubs and woody vines to supplement the Arboretum's series of rare and interesting exotic species.

By November our carefully selected list of available seeds was ready for distribution to a mailing list which includes 39 domestic and 126 foreign gardens and arboreta. To date we have received requests for seeds from 9 institutions in this country and 41 from those abroad.

At the same time that we are filling orders for our own seeds, we are scrutinizing the seed lists sent to us by other arboreta and are submitting our "desiderata" to them. At this season nearly every mail brings from all over the world packets of seeds of plants which will eventually enrich the collections of the Morris Arboretum.

### Flower Show Exhibit

Upon invitation of the Pennsylvania Horticultural Society, the Morris Arboretum prepared an Exhibit of Medicinal Plants for display in the Philadelphia Flower Show which was held during the week of March 10. This exhibit took the form of a small garden containing nearly 70 species of plants used as drugs in various countries.

In addition to a number of familiar species, such as digitalis, quinine, nux-vomica, ephedra, etc., which are officially recognized in the United States Pharmacopeia, there were included many plants regarded as important sources of drugs in such regions as India, China, Africa, Mexico and tropical America.



Fig. 8.



Fig. 9.

Each plant was accompanied by an attractively prepared label giving its common name as well as a number which enabled it to be indentified on a key containing information concerning its value in medicine.

Although not in competition, this exhibit was given the Award of Merit of the Garden Club Federation of Pennsylvania. (Figs. 8 and 9).[1]

All of these plants, and many others which for want of space could not be included, will be displayed in the Arboretums' outdoor Medicinal Plant Garden which will be opened to the public during the summer of 1958.

As previously reported in these pages this garden is being made possible through the Founder's Fund Award of the Garden Club of America.

J.M.F., Jr.

[1] Illustrations by Edmund B. Gilchrist, Jr.

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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| | | Donor | $500.00 |

# Arboretum Activities

## March Storm

The severe snow storm which ravaged this area on March 21 wrought tremendous havoc at the Arboretum. In fact the damage suffered here was comparable only to that inflicted by Hurricane Hazel in the autumn of 1954.

The number of trees actually destroyed by the storm was amazingly small and nothing of great value was lost. The real tragedy lay in the mutilation of many fine mature specimens and the widespread damage to evergreen shrubbery either through the sheer weight of wet snow or by the crashing of large branches from nearby trees.

Strangely enough, the sections of the grounds least affected were the ridge between Gates Building and the Mansion and the north slope. Here, apparently, the wind kept the snow from accumulating on the branches, whereas in the low "protected" hollows of the south slope the full weight of the snow lay inches deep on everything.

*(Continued on Page 35)*

# Characteristics and Identification of the Soft Pines Cultivated in the Philadelphia Area

Jonathan W. Wright[1]

## INTRODUCTION

The Philadelphia area has one of the most complete collections of soft or white pine varieties and species in the world. There are two reasons for this: the region has long been a botanical center, and the white pines find Philadelphia to their liking. Most of the white pine species are found only in arboreta or large estates. However, several would prove useful in the row-house gardens, suburban yards, and forests of southeastern Pennsylvania.

The white pines come in a variety of shapes and sizes. The bristlecone pine (*Pinus aristata* Engelm.) becomes one of America's oldest trees, but is typically slow growing and shrubby. It could safely be used in foundation plantings underneath a front picture window. So could the dwarf stone pine (*P. Strobus* L. var. *nana* Carr.).

The row-house dweller who wishes an erect small tree can use the Swiss stone pine (*P. Cembra* L.) or the Macedonian white pine (*P. peuce* Griseb.). The former grows about 4 inches per year; the latter 8 to 10 inches per year. Both are single-stemmed and have narrow conical crowns. Both are capable of becoming large trees, but not in the average man's lifetime.

The lacebark pine (*P. Bungeana* Zucc.) can find a place in almost any garden. It grows about one foot per year and typically is a many-stemmed large shrub or small tree. Its sparse foliage sheds very light shade in the shelter of which violets and other semi-shade flowers can thrive and bloom profusely. (Fig. 10)

The suburbanite with a half-acre lot has his choice of these or larger species. The eastern white pine (*P. Strobus* L.) is commonly planted and grows rapidly. It makes a compact evergreen hedge if clipped regularly. The Himalayan white pine (*P. Griffithii* McClel.) grows nearly as fast and becomes a large tree. (Fig. 11) It has long, graceful, drooping needles, and casts a light shade. The limber pine (*P. flexilis* James) is also a fast grower and frequently looks like an exceptionally dense and blue form of eastern white pine. (Fig. 12) The Korean white (*P. koraiensis* Sieb. & Zucc.), Armand (*P. Armandi* Franchet), Mexican white (*P. ayachahuite* Ehrenb.) and Japanese white pines (*P. parviflora* Sieb. & Zucc.) are other species that reach large sizes and make specimen trees. (Figs. 13, 14, 15).

The forestry possibilities of the exotic soft pines have barely been investigated. In several areas of New York western white pine (*P. monticola* Dougl. ex D. Don) compares favorably with native species. (Fig. 16) It is finer branched and much more weevil-resistant than the eastern white pine, and is fast growing. The Himalayan and Mexican white pines should be tested in the warmer parts of the region. The very hardy Korean white pine should prove useful as a timber and nut producer in cold regions.

### Importance of White Pines

The early New England settlers were impressed with the eastern white pine. They had seen nothing like it in old England or northern Europe. Its tall straight trunks were just the thing for masts for England's men of war, and the best trees were marked with a broad arrow and saved for the King's navy. The colonists found eastern white pine good for houses, too. This species furnished the lumber for many New England mansions that are still livable after 100 or more years. If eastern white pine has at times fallen from favor, it is only because of overcutting. At present it is again important, even though the present stands do not produce the high quality, knot-free lumber that came from the virgin forests. Even low quality white pine is in demand for pine panelling, boxes, and pattern stock. As the center of the lumber industry moved to the far West in the early years of this century, other white pine species were cut. Western white pine formed the mainstay of the lumber industry of the Inland Empire. In California, lumbermen found the sugar pine (*P. Lambertiana* Dougl.), the largest of all pines, to be a valuable species. Lumber of all three of these species is used inter-changeably although the western species are practically the only source of knotfree boards.

[1]) Associate Professor of Forestry at Michigan State University, East Lansing, Michigan. Most of the observations recorded in this article were made when Dr. Wright was geneticist at the Northeastern Forest Experiment Station of the U.S. Forest Service. The forest genetics work is in cooperation with the Morris Arboretum of the University of Pennsylvania at Philadelphia, Pennsylvania.



Fig. 10. The Lacebark pine, Morris Arboretum.

The woods of all the white pines are similar in being soft, durable, easily worked, not subject to warping after being properly dried, and capable of holding paint well. Thus, any of the species could form the basis of a large lumber industry. However, only two other species — Korean white and Himalayan white pines — grew in sufficient quantity to have provided the basis for anything except local industry. For example, the limber pine grows in high, inaccessible locations in the Rocky Mountains and is frequently wind blown and crooked. Thus, it is rarely used for lumber even though its wood is potentially valuable.

The properties which make white pine wood suitable for many building purposes also make it excellent for matches, and most American wooden matches are made from eastern or western white pine. Strangely, this is a very demanding use, and matches are made from the highest quality rather than the lowest quality lumber. The white pines make poor pulpwood and paper and are rarely cut for this purpose.

In the southwestern United States, Korea, and Afghanistan there are large-seeded white pines which are used as sources of human food. The southwestern tree is known as the pinyon (*P. cembroides* Zucc.). The seeds are collected by the Indians and are included in many brands of mixed nuts. The Korean white pine has seeds more than one-half inch long. In good seed years these seeds form an important source of food in Korea and Japan. It is a pity that the Afghanistan Gerard pine (*P. Gerardiana* Wall.) is probably not hardy in our area because its nuts are extremely large and tasty.

The barks of the white pines contain many chemical compounds but there is no record of even minor industries having utilized these compounds.

The white pines are occasionally used as Christmas trees. A few winters ago I noticed young Himalayan white pine decorating a store front in Norristown, Pennsylvania. The long, drooping foliage had been lightly sprayed and was effective without tinsel or other ornament. Two winters ago a Detroit dealer received the exorbitant price of $20.00 for a single young eastern white pine. Evidentally the buyer liked the tree and did not know that it was one of Michigan's commonest species.

The cut boughs of eastern white pine are commonly included in Christmas wreaths. And one Philadelphia nurseryman who has a few old Himalayan white pines occasionally sells small branches with cones attached. They are in demand because this species produces the largest cones of any pine growing in the state. The very



Fig. 11. A large Himalayan white pine at Morris Arboretum.

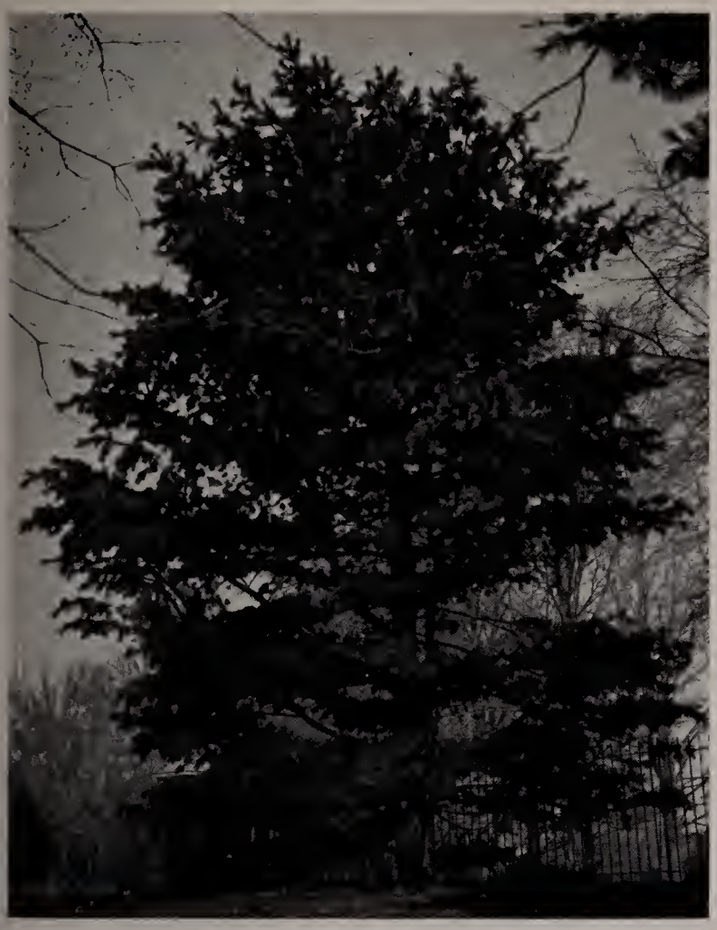


Fig. 12. Limber pine, Morris Arboretum.

large cones of sugar pine are common home decorations. When so used they are prepared by dipping in boiling water to spread the resin in a thin, shiny layer.

As proof of their popularity and importance the white pines are the state trees of several states: eastern white pine – Maine, Michigan, and Minnesota; western white pine – Idaho; and pinyon – Nevada.

### Botanical and Genetical Classification

The genus *Pinus* is divided into two sub-genera, HAPLOXYLON (white or soft pines) and DIPLOXYLON (hard pines). These could be recognized as genera because they are as distinct from each other as are the spruces from the firs. The sub-genus HAPLOXYLON is characterized by having leaves with one fibro-vascular bundle, usually without stomata on the back; bracts of leaf-bundles not decurrent on the branchlet; leaf-bundle sheaths deciduous; wood soft, with little resin and with indistinct annual rings; and male flowers appearing in the spring.

The sub-genus HAPLOXYLON is in turn subdivided into two sections, six series, and about 25 species. Keys to the series and hardy species are given in table 1. These keys were prepared from Elwes and Henry (1909), Little (1953), Martinez (1948), Rehder (1940), and Sargent (1905).

Table 1. Key for the identification of white pine series and species that are hardy or probably hardy in Philadelphia.

#### Key To Series

A. Leaves in bundles of five; conelets unarmed; umbo of cone scales terminal, covered with resin; mostly 1-stemmed trees. Sect. CEMBRA

B. Cones ovoid or conic-ovoid; cone scales fleshy, usually reflexed at tips.

C. Cone indehiscent; seeds wingless. CEMBRAE

*(P. koraiensis, P. pumila, P. Cembra, P. albicaulis)*

CC. Cones dehiscent; seeds winged. FLEXILES

*(P. flexilis, P. strobiformis, P. Armandi)*

BB. Cones cylindric or conic-ovoid; cone scales thin, usually appressed. STROBI

*(P. Lambertiana, P. ayachahuite, P. parviflora, P. peuce, P. Griffithii, P. monticola, P. Strobus, P. formosana)*

AA. Leaves in bundles of one to five; scales of conelets armed with a short prickle; umbo of cone scale armed with a prickle or spine, not covered with resin; mostly many-stemmed trees or large shrubs. Sect. PARACEMBRA



Fig. 13. Korean pine, Morris Arboretum.

C. Leaves entire, 1 to 2 inches long; bark ridged or flaky, dark gray.
D. Leaves in bundles of one to four; seeds wingless. CEMBROIDES
*(P. cembroides, P. edulis, P. monophylla, P. quadrifolia, P. Pinceana, P. Nelsoni)*
DD. Leaves in bundles of five, without stomata on back; seeds winged. BALFOURIANAE
*(P. Balfouriana, P. aristata)*
CC. Leaves serrulate, stout, sharp-pointed, 2 to 4 inches long; bark light-colored, exfoliating in large scales. GERARDIANAE
*(P. Gerardiana, P. Bungeana)*

### Key To Species[2]

A. Leaves in bundles of five.
B. Leaves serrulate, rough to touch when rubbed backwards.
C. Shrubs without a single central stem; leaves 2 to 3 inches long; cones ovoid, 1 to 2 inches long. *P. pumila**
CC. Trees with a single central stem.
D. Leaves 5 to 8 inches long, bent, drooping; foliage thin; branchlets brittle, covered with bloom; cones long-stalked (stalks 1 to 2 inches long), borne over entire crown. *P. Griffithii*
DD. Leaves 2 to 6 inches long, not bent; branchlets not bloomy; cone-stalks less than ½ inch long.
E. Branchlets tomentose or pubescent.
F. Trees narrow-pyramidal, horizontal-branched, growing 4 to 5 inches per year; cones indehiscent, 2 to 3 inches long, borne only in top of crown. *P. Cembra*
FF. Trees conical or broad-crowned, growing more than 10 inches per year.
G. Bark of trunk orange, flaky; cones 4 to 6 inches long, indehiscent; cone scales thick, with recurved tips. *P. koraiensis*
GG. Bark of trunk gray, smooth or fissured; cones dehiscent; cone scales thin.
H. Leaves bluish green, without stomata on back.
I. Foliage dense; leaves 2 to 6 inches long; cones short-stalked, cylindric, 4 to 12 inches long.
J. Trees conical; leaves 2 to 4 inches long; cones 4 to 10 inches long; cone scales appressed at tips. *P. monticola*
JJ. Trees broad-crowned; leaves 4 to 6 inches long; cones 8 to 16 inches long; cone scales reflexed at tips. *P. ayacahuite*
II. Foliage sparse; leaves 1 to 3 inches long; cones 2 to 4 inches long, ovoid, sessile. *P. parviflora*
HH. Leaves with conspicuous stomatic bands on back, stout, 3 to 4 inches long; cones 10 to 20 inches long. *P. Lambertiana**
EE. Branchlets glabrous or pubescent for only a short time.
F. Narrow-crowned trees growing 8 to 12 inches per year, with ascending branches; cone scales thin, convex; cones short-stalked, sub-cylindric, 3 to 6 inches long. *P. peuce*
FF. Broad-crowned trees growing 12 inches or more per year, with horizontal branches.
G. Buds cylindric, chestnut brown; branchlets coarse; cones 4 to 8



Fig. 14. A young tree of the Armand pine, Morris Arboretum.

[2] Species marked with an asterisk are not present in Philadelphia.

inches long, ovoid, heavy; cone scales thick. *P. Armandi*

GG. Buds ovoid, tawny; cones cylindric; cone scales thin.

H. Cones 8 to 16 inches long; cone scales reflexed. *P. ayacahuite*

HH. Cones 3 to 8 inches long; cone scales appressed; branchlets fine. *P. Strobus*

B. Leaves entire, persistent 5 or more years, smooth to touch when rubbed backwards; cone scales thick.

C. Leaf sheaths deciduous soon after leaf expansion; leaves with stomata on back, 2 to 4 inches long, persistent for 5 to 6 years; cones unarmed; branchlets tough, flexible; seeds wingless; cones 2 to 9 inches long.

D. Leaves stout, 2 to 3 inches long; unripe cones purple, 2 to 3 inches long, indehiscent; bark of trunk broken into light brown or white platelike scales. *P. albicaulis**

DD. Leaves slender, 2 to 4½ inches long; unripe cones green, 3 to 9 inches long, dehiscent; bark of trunk dark grey.

E. Cones 3 to 6 inches long; cone scales rounded at tip, not reflexed; bark of trunk plated. *P. flexilis*

EE. Cones 4 to 9 inches long; cone scales reflexed; bark of trunk deeply ridged. *P. strobiformis*

CC. Leaf sheaths persistent for one or two years; leaves without stomata on back, 1 to 2 inches long, persistent for 10 or 12 years; cones armed with a prickle; seeds winged.

D. Branchlets light orange, glabrous; leaves dotted with resin; cones 2 to 4 inches long, armed with a long, slender prickle; usually a shrub. *P. aristata**

DD. Branchlets dark orange-brown, puberulous; leaves not dotted with resin; cones 3 to 5 inches long, armed with a short, incurved prickle. *P. Balfouriana**

AA. Leaves in bundles of one to four; small trees, usually many-stemmed.

B. Leaves in bundles of three, serrate, light green; bark exfoliating in large scales, leaving a smooth, whitish bark mottled with orange or brown; seeds with short wings. *P. Bungeana*

BB. Leaves dark green, entire; bark dark gray; seeds wingless.

C. Leaves in bundles of one (or two). *P. monophylla*

CC. Leaves in bundles of two (or three). *P. edulis*

CCC. Leaves in bundles of three (or two). *P. cembroides**

CCCC. Leaves in bundles of four (or three to five). *P. quadrifolia**

It is usually possible to identify a white pine with certainty even though it does not bear cones. The slow growth and short horizontal branches are characteristic of the Swiss stone pine. So, too, are the planetree-type bark of lacebark pine and the long, bent needles of Himalayan white pine.

In recent years the chemistry of the white pine has been under study in California (Mirov, 1953). The results indicate that the species are as distinct with regard to chemical composition of their resins as they are in external morphology and growth habit. For example, the whitebark pine is the only white pine species that lacks the turpene alpha-pinene. These studies, in addition to being interesting taxonomically, should shed light on the problem of pest resistance.

Across the northern United States and southern Canada there is a network of research agencies that devote the major portion of their efforts to white pine improvement. These researchers keep in constant touch with each other.



Fig. 15. One of the main stems of a large Japanese white pine, Morris Arboretum.

Pollen from Morris Arboretum has been used in Maple, Ontario; Madison, Wisconsin; Clarkia, Idaho; Placerville, California; and Ely, Minnesota, and pollen from these locations has been used on Morris Arboretum trees. And every year for the past seven years these workers have exchanged information by newsletter.

These genetic studies are farthest advanced in the field of species hybridization. Most of the species in the 5-needled section CEMBRA have been used as parents in one or more interspecific crosses (table 2). On the whole, the ease with which two species can be crossed is correlated with the closeness of their taxonomic relationship. With the single exception of sugar pine, species in the series *Strobi* cross easily with each other, but not with members of other series. Several species hybrids, including *P. flexilis* × *Griffithii, P. ayachahuite* × *Strobus, P. ayacahuite* × *Griffithii, and P. Strobus* × *monticola,* appear to be very fast growing and to hold promise for northeastern foresters.

The success symbols used are:

H= Hybrids produced and authenticated.
U = Undetermined. Full seeds produced but yet authenticated.
F = Failure.
A = Attempted. Success not yet known.

The study of geographic variation within species is progressing slowly. We know a little about the variability of western white pine but the first serious study of geographic variability in eastern white pine was started only in the fall of 1955.

For several years workers in Wisconsin and Washington have been diligently searching for individual trees resistant to the blister rust fungus. They have been successful and are now trying to breed resistant strains.

### Synopsis By Species[3]

In the Philadelphia area there are thrifty, living representatives of 13 of the approximately

[3] Much of the information in this section was taken from a forthcoming publication by W. J. Gabriel and the author.

Table 2. Summary of species crosses made within the section CEMBRA. (Compiled from unpublished data in the files of the Northeastern Forest Experiment Station.)

| Series and Species | Series and Species | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CEMBRAE | | | | STROBI | | | | | | FLEXILES | | | | | |
| | koraiensis | pumila | Cembra | albicaulis | flexilis | strobiformis | Armandi | Lambertiana | ayacahuite | parviflora | peuce | Griffithii | monticola | Strobus | formosana |
| CEMBRAE | | | | | | | | | | | | | | | |
| koraiensis | — | — | | | | | | | | | | | | | |
| pumila | — | — | | | | | | | | | | | | | |
| Cembra | A | — | F | | | | | | | | | | | | |
| albicaulis | F | — | F | — | | | | | | | | | | | |
| FLEXILES | | | | | | | | | | | | | | | |
| flexilis | F | — | F | — | F | | | | | | | | | | |
| strobiformis | — | — | — | — | F | F | | | | | | | | | |
| Armandi | U | — | — | — | U | F | F | | | | | | | | |
| STROBI | | | | | | | | | | | | | | | |
| Lambertiana | H | — | — | F | F | F | H | — | | | | | | | |
| ayacahuite | F | — | F | — | H | — | — | — | H | | | | | | |
| parviflora | — | — | F | — | F | — | — | — | F | — | | | | | |
| peuce | F | — | — | — | — | — | — | — | F | — | H | | | | |
| Griffithii | — | — | F | — | H | — | F | — | F | H | H | U | | | |
| monticola | U | — | — | — | A | — | U | — | F | H | H | H | H | | |
| Strobus | F | — | F | F | H | — | F | — | F | H | H | H | H | H | |
| formosana | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Strobus var. chiapensis | — | — | — | — | — | — | — | — | — | — | — | U | — | — | — |



Fig. 16. Western white pine, Morris Arboretum.

25 white pine species. These are treated in detail later.

Another eight species are known to grow in the Northeast, and would probably prove hardy in Philadelphia. The western American bristlecone pine (Fig. 17) is one that should certainly be tried. Several years ago it was grown in quantity by the New York state forestry nursery near Saratoga Springs. One bunch of seedlings that was heeled in a crowded trench has remained alive for 20 years. Another was outplanted on an old field in the Adirondacks and is now a group of 3- to 8-foot-tall shrubs perfect for foundation plantings.

The border white pine (*P. strobiformis* Engelm.) from Arizona and northern Mexico grew faster than eastern white pine in forest plantings in Montgomery County, New York. (Fig. 18). This species is poorly known and has at various times been called *P. reflexa* Engelm. and *P. flexilis* var. *reflexa* Engelm. or has been confused with Mexican white pine. The 35- to 40-foot trees in these plantings have swollen nodes and deeply ridged lower bark, reminiscent of the bark of the chestnut oak (*Quercus prinus* L.).

There are two old grafted trees of the California sugar pine in the Arnold Arboretum in Boston. At the Morris Arboretum the seeds germinated, the seedlings grew rapidly, survived the critical first two winters, but failed to survive transplanting.

The Mexican and Parry pinyons (*P. cembroides* Zucc., and *P. quadrifolia* Parl.) are so similar in range and habit to the singleleaf pinyon and pinyon (*P. monophylla* Torr. & Frem., and *P. edulis* Engelm.) that they will probably prove similar to those species in ability to grow in the Philadelphia area.

I have not seen northeastern specimens of the whitebark pine (*P. albicaulis* Engelm.), the foxtail pine (*P. Balfouriana* Grev. & Balf.), or the dwarf stone pine (*P. pumila* (Pallas) Regel), but Rehder (1940) lists them as growing in this region.

There are four species of white pines that will probably not prove hardy in Philadelphia. The Formosan white pine (*P. formosana* Hayata) was grown in the Northeastern Forest Experiment Station's experimental nursery one year. It grew rapidly but the leaves were brown long before Christmas and none of the seedlings survived their first winter. The Afghanistan Gerard pine, the Mexican Pince pine (*P. Pinceana* Gord.), and the Mexican Nelson pine (*P. Nelsoni* Shaw) all come from regions with relatively warm winters.



Fig. 17. This slow-growing bristlecone pine would be ideal at the corner of a house.



Fig. 18. The little-known border white pine gets off to a slow start but then grows as rapidly as do some of our native species.

The following comments apply to species that have been tested in southeastern Pennsylvania.

### Armand Pine *(P. Armandi* Franchet)

Armand pine is a native of southwestern China, where it grows at elevations of 4,000 to 6,000 feet, and reaches heights of 50 to 60 feet. This species has proved hardy at Rochester, New York, where the 40- to 50- year-old specimens are now about 50 feet tall. Younger specimens at the Morris Arboretum are growing vigorously, but exhibit slight winter dieback. (Fig. 14). These differences are possibly due to differences in seed origin, and further seed importations should be from the coldest parts of the species' range. A hardy race would be in demand because of its relatively long needles and blue-green foliage.

Armand pine has one peculiarity that the tree breeder likes. It flowers early without special urging. Even 3- to 5-foot specimens regularly produce abundant pollen.

### Eastern White Pine *(P. Strobus* L.)

Eastern white pine is the most wide ranging and important of all the white pines. It grows naturally from the maritime provinces to western Ontario and Minnesota, and south along the Appalachian Mountains to northern Georgia.

The Chiapas white pine *(P. Strobus* var. *chiapensis* Martinez) of Guatemala and southern Mexico looks like eastern white pine, and grows in company with about 500 species of mosses, herbs, shrubs, and trees that are normally considered Appalachian species. It also grows with palms, orchids, and coffee. Strangely, this representative of a northern species grows at the lower part rather than the higher part of the Mexican pine forest. Several years ago Chiapas white pine was tried in Philadelphia. It promptly winterkilled.

Eastern white pine grows well in Philadelphia. On good soils isolated trees grow about 0.6 inches per year in diameter and about 2 feet per year in height. Yet it was not native, probably because it cannot set good seed. The Philadelphia trees flower regularly, but the cones contain an average of 1.1 good seeds per cone, in contrast with yields of 40 to 70 good seeds per cone in native stands.

Foresters in many parts of the world find this species a useful addition to their forests. In Europe it is known as Weymouth pine (after Weymouth, England) and is widely planted in England, Germany, France, Italy and Rumania.



Fig. 19. A young tree of the Himalayan white pine, Morris Arboretum.



Fig. 20. Foliage of the Himalayan white pine.

Recently it has shown promise in southern Sweden. It is also used in Japan and South Korea. The New Zealanders have gone so far as to prepare volume tables. They could not use ours because it grows much more rapidly down under.

### Himalayan White Pine (*P. Griffithii* McClel.)

The Himalayan white pine is a native of the Himalayan Mountains, where it grows from Nepal to Afghanistan at elevations of 6,000 to 12,500 feet.

Philadelphia and its suburbs contain numerous 60-year-old specimens, 60 to 70 feet tall and 1½ to 2½ feet in diameter breast high. (Fig. 11) These older trees were probably all started from seed at the same time and were probably sold by one of two nurseries—Andorra or Meehan's—which stocked them early in the century. Most of these oldsters are still growing vigorously in height and diameter, and many are the tallest trees in their neighborhoods. There are also old specimens of Himalayan white pine near Poughkeepsie, New York and in Rochester, New York and thrifty young specimens near Bethlehem, Pennsylvania. However, it has not proved hardy in the Adirondacks.

The long, drooping needles and the large spreading branches gives this species a peculiar grace not found in other hardy pines. (Figs. 19 and 20). It is definitely not a tree for the small garden. However, it can be used in the medium-sized yard to furnish light shade under which semi-shade plants can be grown.

The seeding habits of this species are puzzling. Several times I have collected more than a half a bushel of cones from a tree that seemed adequately pollinated, only to find that the seeds were nearly all empty. Yet a nearby tree might yield almost a quart of viable seeds the same year.

### Japanese White Pine

(*P. parviflora* Sieb. & Zucc.)

The Japanese white pine is a native of the mountains of Japan and the Kurile Islands. In its native habitat it is a species of poor timber form and moderate growth rate, and is of little commercial importance. However, it is used in Japanese gardens.

The branches of the Japanese white pine are not exceptionally large, but they are long. Even in young trees the crowns are frequently as broad as tall. The blue-green foliage is shorter than in most white pines.

The Morris Arboretum contains two specimens which were planted as parts of Japanese gardens. They have picturesque, crooked trunks —possibly as the result of early training. (Fig. 15) Specimens in other Philadelphia arboreta have straight trunks.

The seeds of Japanese white pine are so large in comparison with the size of the cone that they cause noticeable bulges in the ripe cones. Therefore, even without X-ray eyes, it is possible to count the number of full-sized seeds – but not to tell how many are filled – in unopened cones.



Fig. 21. The Macedonian white pine nearly always has a regular, conical crown.

### Korean White Pine

*(P. koraiensis* Sieb. & Zucc.)

Korean white pine is an important timber and nut tree of the mountains of Korea and Manchuria. Judging from the rigorous climate of its homeland, it should be among the hardiest of the white pines – possibly even hardier than eastern white pine.

The illustration accompanying the original description and the original Latin diagnosis apply to a composite specimen made up to parts of Korean white, Japanese white and dwarf stone pines. This description appeared in 1844 but verbatim copies or translations appeared in the taxonomic works of other authors until about 1890.

The two Morris Arboretum trees (one is now dead) grew a few inches per year (Fig. 13) whereas each of the three specimens in the Westtown School Arboretum near Westchester, Pennsylvania grew more than 1½ feet in height per year. This extreme difference is probably due in large part to differences in geographic origin of the seed. The handsomest specimen I have seen is on grounds of the former Cluett estate, near Williamstown, Massachusetts. That 35-year-old tree is 60 feet tall, 10 inches in diameter breast high, and has a perfectly straight trunk. At first glance one thinks he has made a dendrological mistake. The bark is just like that of red pine *(P. resinosa* Ait.) but the bundles are 5-needled.



Fig. 22. This 26-inch Mexican white pine has outstripped eastern white pine in diameter but not in height growth.

### Lacebark Pine

*(P. Bungeana* Zucc.)

The lacebark pine is a native of western China, where it grows in open woodlands. Under natural conditions and in this country it is typically a branchy, many-stemmed small tree.

The most distinctive characteristic of lacebark pine is its bark, which exfoliates in layers and is colored like the bark of the planetree. Because of this bark there seems to be almost universal agreement among visitors to the Morris Arboretum that this tree is one that should be in every garden. (Fig. 10).

The lacebark pine is moderately fast growing, putting on about one foot in height per year. It seems to be quite hardy. A vigorous specimen in Ann Arbor, Michigan has stood winters colder than Philadelphia.

### Limber Pine *(P. flexilis* James)

Limber pine is a tree of high elevations in the Rocky Mountains. Because of its inaccessibility and branchiness, it is of minor importance in its native range.

This tree gets both its common and scientific names from its pliable branches, which are a blessing to the tree breeder. When applying pollination bags I used regularly to break off a large percentage of the branchlets of the brittle-wooded Himalayan white pine. Not so with limber pine, the branchlets of which can be bent almost double.

A visitor from the Rocky Mountains would be amazed at the Philadelphia trees. They do not have a windswept appearance. Instead, they are straight-trunked and fast growing. In fact, a few specimens are outgrowing eastern white pines planted nearby.

This species has a peculiar branch habit (Fig. 12). Often the lower branches start to turn upward at the tips when the trees are about 20 feet tall. These branches then become secondary trunks. One 60-foot specimen now has a lower branch 50 feet tall.

The growth relations of limber and western white pines are puzzling. In the northern Rocky Mountains the former grows at higher elevations than does the latter. Therefore, the limber pine might be expected to grow better than western white pine in the cool Adirondacks and poorer than western white pine in warm Philadelphia. However, the reverse is true, for limber pine grows better in Philadelphia and western white

pine grows better in the Adirondacks. Differences in seed origin probably explain part of this anomaly.

### Macedonian White Pine (*P. peuce* Griseb.)

Macedonian white pine (Fig. 21) is native to three small areas in the mountains of Greece, Bulgaria, and Yugoslavia, where it grows at elevations of 2,500 to 7,300 feet. In its native habitat it attains heights of 100 feet in 100 years, has excellent timber form, and is a locally valuable timber tree.

This species is typically moderately fast growing, with short, slender, ascending branches and a straight stem. It is uniform, and looks the same whether seen in Michigan, New York, Connecticut or Pennsylvania. In fact, the fastest growing specimen in Philadelphia (22 feet tall, 5 inches in diameter, breast high, about 20 years old from seed) has about the same dimensions as similar-aged trees in natural European stands.

### Mexican White Pine (*P. ayacahuite* Ehrenb.)

The Mexican white pine (Fig. 22) is a taxonomically variable species of which three geographic varieties are recognized. Within its native range, which extends from Guatemala to northern Mexico, it is a high mountain species of local importance as a timber producer.

It is surprising that this species should be hardy in Philadelphia and Rochester, New York, yet specimens have survived about 40 winters in both places. Later importations from two localities in Mexico failed to survive the first winter.

In the Northeast this species grows faster in diameter but slower in height than eastern white pine. All trees are rather broad-crowned, and have denser foliage than the latter species. They produce many (1,000 or more per tree some years) large cones over the entire crown.

One 35-year-old tree in the Westtown Arboretum near Westchester, Pennsylvania has been a most faithful brood mare. The Northeastern Station has used it in tree breeding operations and year after year has obtained a bountiful crop of hybrid seeds. Sometimes these hybrids came with no effort — merely as the result of wind pollination from nearby eastern white pine. Young hybrids (Fig. 23) being tested near Philadelphia are growing about as fast as eastern white pine.

### Pinyon (*P. edulis* Engelm.) and Singleleaf Pinyon (*P. monophylla* Torr. & Frem.)

These species grow in the Rocky Mountains from southern Idaho to northern Mexico and from southeastern California to extreme northwestern Oklahoma. They generally occur in open woodlands at the lowest limit of tree growth.

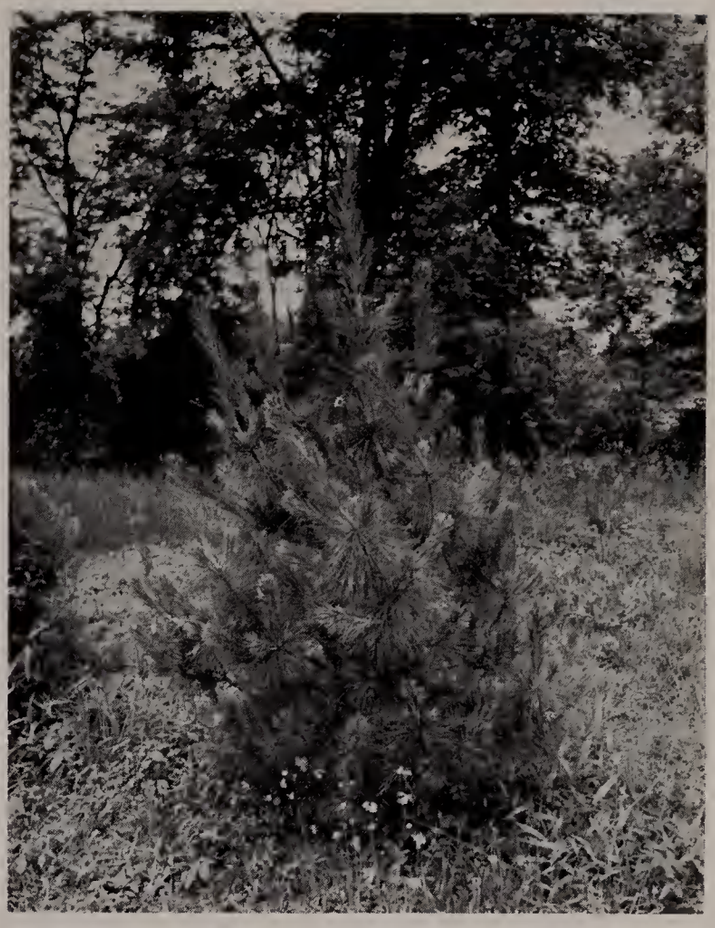


Fig. 23. Hybrids between Mexican white and eastern white pine show early promise of very rapid growth.

In their native habitats the pinyons are typically broad-crowned small trees which are valuable mainly for their large, edible (whence the name *edulis*) nuts. These nuts are gathered by the Indians and occasionally find their way into expensive nut mixtures.

The few specimens in Philadelphia are growing much as they would in their native, dry habitats. In fact, each looks as if it could have been transferred bodily from an Arizona landscape. This even refers to the seed production because occasionally the lone Morris Arboretum *P. edulis* produces selfed but full seeds. (Fig. 24)

### Swiss Stone Pine (*P. Cembra* L.)

The Swiss stone pine is distributed widely in Siberia and in the mountains of central Europe. (Fig. 25). It is likely that most of the northeastern trees belong to the typical Swiss variety (*P. Cembra* var. *Cembra*). It derives its common name from the large seeds or "stones".

The Swiss stone pine is now too rare and inaccessible to be cut much for timber. However, it was used by prehistoric man in the Swiss lake dwellings.

In the Northeast the oldest and largest tree of which I have a record is on the Remington estate, Cazenovia, New York. Planted in 1856, it was 59 feet tall and 26 inches in diameter breast

high when measured in the spring of 1957..[4] Another large tree, 80 years old, 39 feet tall, and 18 inches in diameter breast high, grows near Beacon, New York. One Morris Arboretum specimen will soon reach this height but is much smaller in diameter. All the Swiss stone pines can be characterized as straight-boled, fine-branched, dense-foliaged, slow-growing, and ideal for small gardens.

### Western White Pine

(*P. monticola* Dougl. ex D. Don)

Western white pine is one of the most important western American timber trees. (Fig. 16) It grows naturally in the Sierra Nevada and Cascade mountains of California, Oregon, and Washington, and in the northern Rocky Mountains of Idaho, Montana, and British Columbia. Its natural range is now shrinking considerably due to the ravages of the white pine blister rust.

[4] These measurements were furnished by E. W. Littlefield, Assistant Director, Division of Lands and Forests, Albany, New York.



Fig. 24. Pinyon pine, Morris Arboretum.



Fig. 25. The tall but compact Swiss stone pine makes an excellent specimen tree for small gardens.

Western white pine appears to be a slow starter but after 7 or 8 years it grows at about the same rate as eastern white pine. Except for form — it has a narrower crown and finer branches — it is similar in general appearance to the eastern species.

The few specimens in Philadelphia are growing well. A forest plantation near Saratoga Springs, New York is doing excellently. The trees are a little taller than nearby eastern white pine planted at the same time, and have only 20 percent as many weevilings. This lack of weeviling makes the tree of especial interest to foresters.

Eastern and western white pines can be crossed with ease, and the hybrids outgrow both of the parents. With further research these hybrids should prove very useful in the forests of the Northeast.

*(To be continued)*

# Fertilizing Trees and Shrubs

Mary O. Milton

If trees and shrubs are to grow well they must have an adequate supply of nutrient elements, and if these nutrients are not naturally present in the soil they must be supplied by the application of fertilizers. Plants which are in a weakened condition from the lack of sufficient nutrients not only look unsightly, they are far less able to withstand droughts, severe winters, and are much more susceptible to damage by wind, insects and disease.

Forest trees which grow in their natural environment have only other trees to compete with for nutrients and water. Their roots and nutrient supplies are not restricted by streets and sidewalks, underground pipes, and buildings. The mulch of organic materials naturally supplied them replaces many of the elements taken from the soil by the normal growth of the trees. While the actual nutrients supplied by these organic materials are very low in comparison with commercial sources of mineral nutrients, it is regularly supplied, and mulches are of special benefits in improving and maintaining soil texture. On the other hand, ornamentals are often grown in open, closely clipped lawns, their roots subjected to drying, extreme temperature changes, and in many cases are grown in subsoil covered with an inch or so of top soil. In other words, ornamentals often have adverse growing conditions made worse by insufficient nutrient elements.

If a tree or shrub is growing well, flowering and fruiting in a satisfactory manner, in all probability it has available the elements necessary for maintenance and growth. Nutrient element deficiencies are normally evidenced by distorted or discolored foliage, sparse growth, and a general decline in vigor. However, sucking insects can cause yellowed, distorted leaves or borers can enter the trunk of a tree or shrub and produce symptoms much like those of nutrient deficiencies. Industrial gases, improper drainage, too much or too little shade may also be a cause for poor vigor. There are some symptoms that will, with a little practice, indicate what general deficiencies are present. The following table by Dr. Carl G. Deuber includes the more obvious ones.

| Symptoms | Cause |
|---|---|
| 1. Poor leaf growth which causes: | |
| a. Dwarf plants, yellowish color | lack of nitrogen |
| Dwarf plants, grayish color | lack of phosphorous or potash |
| b. Tall, spindly plants | lack of light |
| 2. Chlorosis or yellowing of leaf | |
| a. Uniform all over leaf | lack of iron, excess of lime magnesium, sodium, potash, carbonates, manganese |
| b. Patchy, spreading from midrib outward | lack of magnesium |
| c. Mottled | lack of lime |
| d. Spotty | lack of potash |
| e. Leaf yellowing, then drying at tip and from edges inward | lack of potash |
| f. Leaf yellowing then drying from midrib outward | lack of nitrogen |
| 3. Patches on leaf | |
| a. Brown patches like 'scorching' | lack of potash |
| b. Brown patches chiefly in center | lack of magnesium |
| 4. Rich green leaves and large thick stems | large supply of nitrogen |
| 5. Dark colored leaves, tendency to crinkle | lack of potash in relation to nitrogen |
| 6. Patchy appearance of foliage, some dark green, others lighter | acidity of soil |

The only truly reliable way to know just what elements are either lacking or are in overabundance is to have the soil tested by a reliable soil testing service such as the county agricultural agent. Often manufacturers of commercial fertilizers have a customer soil testing service. Samples should be collected from several different places in the growing area, one or two tablespoons from each spot, and taken from 2 or 3 inches below the surface. The soil should be dried before packaging to send away for testing.

It is a good policy first to determine the physical condition of the soil. While an application of fertilizer may serve as a "shot in the arm" and help overcome, or rather endure, adverse grow-

ing conditions it certainly will not cure all ills. No matter what the nutrient content of the soil, if there is improper drainage, poor soil texture, disease or insects, or it is too acid or too alkaline for the plants growing in it, plants will not thrive.

Fertilizers, both chemical and organic, are often referred to as plant foods. Actually they are not foods at all — they furnish the nutrients necessary for the manufacture of food. The green coloring in leaves, chlorophyll, manufactures the basic food for the plant, and if the nutrients necessary for the formation of chlorophyll are not sufficient, plants cannot maintain themselves.

Inorganic fertilizers are those obtained from mineral sources, and organic fertilizers are those obtained from animal or plant materials. The inorganic fertilizers are usually more quickly available, that is they can immediately be taken up and used by the plant, and are applied in smaller amounts and at shorter intervals than the organic fertilizers. Organic fertilizers are more slowly available and can be used without danger of burning the plant.

Of the many elements necessary for plant growth, nitrogen (N), phosphorus (P), and potassium or potash (K) are those used in greatest quantities. These three elements, N, P, and K, are the constituents of the familiar 5-10-5 fertilizers. These numbers indicate the proportion of nitrogen, phosphorous, and potassium, in that order, and are known as complete fertilizers. Actually they are not complete fertilizers since they do not contain all the elements known to be necessary for plant growth — they have become known as complete fertilizers because they supply the elements most commonly found lacking in soils. A 5-10-5 fertilizer has in a one-hundred pound bag, 5 pounds of nitrogen, 10 pounds of a phosphorous compound, and 5 pounds of a potassium compound, or 5 *parts* nitrogen, 10 *parts* phosphorous, etc. The remaining 80 pounds, or parts, serve as a carrier or spreader for the actual fertilizer. This carrier may or may not have nutrient value and it may have an alkaline, acid, or neutral reaction in the soil. In any case, the carrier facilitates the uniform application of the fertilizer.

Most trees and shrubs will respond satisfactorily to a complete fertilizer and unless the exact deficiencies are known they should be used rather than applying the specific elements alone. Usually fertilizers prepared especially for trees and shrubs are the most reliable and should be used by the average gardener. Some brand names are Agrico for Lawns, Trees and Shrubs, Vertagreen for Turf and Trees, and Espoma for Trees and Shrubs. Most of these fertilizers are 5-10-5, 10-8-6, or 4-6-4 N, P, and K ratios, and are effective and safe for general use. Sandy soils very low in organic matter will require a higher nitrogen content fertilizer and there a 10-6-4, 10-8-6, or 10-10-10 ratio should be used. No matter which prepared fertilizer is used, the directions on the package should be carefully followed.

Nitrogen promotes the vegetative growth of plants, and because it is so easily leached from the soil, it is the element most often found lacking. Plants can easily be damaged by nitrogen and care should be taken to apply the correct amount and to water it well into the ground after application. While trees and shrubs grown primarily for foliage require more nitrogen than do those grown for flowers or fruits, a high nitrogen fertilizer generally should not be used on hedges, as it will promote an undue amount of growth which will require frequent trimming. To induce flowering in shrubs it is often beneficial to reduce the nitrogen and increase the phosphorous and potassium content of the soil.

Some common sources of inorganic nitrogen are ammonium sulfate, calcium nitrate, nitrate of soda, and urea. These elements are quickly available and may burn the plant if care is not used in their application. Organic sources of nitrogen include activated sludge, cottonseed meal, tankage, dried blood, and animal manures.

Phosphorous stimulates root growth and development and increases flower and seed production. It is slowly available to plants and does not leach from the soil. It is often deficient in soils containing large amounts of composted materials and those which receive regular mulches. Common sources are superphosphate and ammonium phosphate.

Potassium promotes strong stems and branches, intensified flower color and is also thought to increase resistance to some diseases. Natural soils which have a high percentage of sand or peat usually have a low potassium content.

The following is a list of common fertilizers, their rates of application, availability, and soil reaction. The amounts given for dry application are for 100 square feet of soil area.

Sodium nitrate — 15% N; readily available; alkaline; dry application 1 pound liquid — 1 ounce per gallon of water.

Calcium nitrate — 15% N; readily available; very alkaline; dry application 1 pound; liquid — 1 ounce per gallon.

Ammonium sulfate — 20% N; readily available; acid; dry application 1-2 pounds liquid — 1 ounce per 2 gallons.

Urea — 46% N; readily available; acid; dry application ½ pound; liquid — 1 ounce per 7 gallons of water. When dry application is

made urea should be mixed with sand to assure uniform distribution.

Ammonium phosphate – mono 11% N, plus 48% P; moderately available; acid; 1-2 pounds; liquid 1 ounce per gallon.

Ammonium Phosphate – di 21% N, plus 53% P; moderately available; acid; 1 pound; liquid – 1 ounce per 5 gallons.

Superphosphate – 20% P; slowly available; neutral; dry application 4 pounds; insoluble in water.

Potassium sulfate – 50% K; readily available; neutral; dry application 1 pound; liquid – 1 ounce per 2 gallons.

Muriate of Potash – 50% K, readily available; neutral; 1 pound, liquid – 1 ounce per 2 gallons.

Some other elements used in lesser amounts are calcium, or lime, which aids in the taking up of N, P, and K by the plant, favors the development of soil bacteria necessary for the breakdown or decomposition of organic matter, and also makes more alkaline, or sweetens an acid soil. An overdose of lime may increase the alkalinity of the soil to a point beyond the range desired. This can prevent the plants using other elements contained in the soil. Iron is a rather common deficiency, and is often mistaken for a nitrogen deficiency. An application of the quickly available iron called chelated iron, will usually give good results. A trade name for chelated iron is "Sequestrene".

Acid loving plants which have been overcared for by the addition of too much acid peat, oak leaf mold, ammonium or aluminum sulfate or other materials which lower the acidity of the soil may also show many deficiency symptoms. This is due to the pH or acidity of the soil being too low to allow the plant properly to use the nutrients in the soil. When the acidity is brought up to a higher pH the nutrients are again available to the plant.

Other elements known as trace or minor elements such as manganese, boron, copper, and zinc are usually present in most garden soils. Deficiencies in these trace elements are best determined by soil tests. Very sandy soils, those low in organic matter, or soils that have been overlimed often are deficient in the trace elements. Many of the complete fertilizers contain these minor elements, and when they are present the label will state so. Fish emulsion and dried blood are very good organic sources of these elements. They can also be purchased in the quick acting or chelated form.

Trees and shrubs may be fertilized in the spring or in late fall after the leaves have fallen and before the ground has frozen to a point which makes application impractical. Foliage feeding is done of course when the tree or shrub is in full leaf. Late summer applications, especially of those fertilizers quickly available to the plant, will many times force soft new growth late in the growing season and will winter kill. Evergreens are particularly susceptible to winter kill from late fertilizing. Fall application has the advantage of making the fertilizer available for the first growth in the early spring, while results from spring application, especially after very dry summers, may not be gotten until the following year.

Large trees may require fertilizing every 3 years or so, and unless it is determined that nutrient deficiencies do exist, fertilizing more often than this may not only be an unnecessary expense, but the application of excessive amounts can seriously damage or even kill the plant. Young trees, especially young evergreens, respond more quickly to fertilizing and are therefore more easily damaged by an overdose. Fast growing shrubs may be fertilized every year or so – however, a reasonably good soil should not require such frequent fertilizing. Plants with special soil requirements such as azaleas, hollies, etc., should have a generous supply of organic materials incorporated in the soil. Roses may require feeding every year, and sometimes twice during the growing season. It very often happens that shrubs and trees live year after year and are perfectly healthy; again some must be fertilized quite often just to keep them alive. The frequency of applications will be determined by the soil conditions and the type of plant.

There are several opinions as to the correct dosage which vary from 1 to 8 pounds for each inch in trunk diameter three feet above the ground. Again, when using prepared brand name fertilizers, follow the directions on the package. A safe application for larger trees is from 2 to 4 pounds for each inch in trunk diameter at chest height. It is far better of course to make a second application than to risk seriously damaging the tree by too heavy an application. Small trees, those with a trunk diameter of less than 6 inches should have 1 to 2 pounds per inch of trunk diameter.

Narrow leaved evergreens such as pines, spruces junipers and hemlocks, are rather easily damaged by excessive amounts of commercial fertilizers. Very young trees of this sort can safely be fertilized with an organic fertilizer such as cottonseed meal or tankage. The nitrogen in these materials is slowly available to the plant, thereby reducing the possibility of burning the tree. This can be applied at the rate of about 5 pounds per 100 square feet, or about 2 cupfuls per plant. This should be scratched into the surface of the soil and watered in to mix well with the soil. Larger narrow-leaved ever-

greens can safely be fertilized with regular 5-10-5, or 4-8-4 commercial fertilizer at the rate of 2 pounds per inch of trunk diameter.

Organic materials such as sawdust, leaves, woodchips, peat, peanut hulls, etc., furnish small amounts of mineral elements. Their chief value is their ability to improve the texture of the soil, permitting better aeration and drainage when actually in the soil, and when applied as a mulch, protecting the roots from severe temperature changes and reduces water loss. While there is no doubt that animal manures are of decided benefit to the soil, their mineral nutrient content, with the exception of nitrogen is many times lower than that of a good complete fertilizer.

When sawdust or woodchips are used as a mulch, extra nitrogen should be applied to compensate for the nitrogen taken from the soil by the bacteria and fungi in decomposing them. When these materials are decomposed, the nitrogen is again available to the plant, but they do require a considerable amount to break them down.

Generally speaking, the feeding roots of trees are located within the radial spread of the branches, and it is in the outer two thirds of this area that fertilizers should be applied. They should never be applied in the area immediately around the trunk as there is danger of burning the base of the tree, and in addition, there are few feeding roots in this area. The roots of shrubs are of course, much more fibrous and are located closer to the main stems of the plant. The radial spread in feet of the roots of trees is usually equal to the trunk diameter in inches a foot or so from the ground. That is, a tree 8 inches in diameter would have a radial root spread of about 8 feet.

While commercial arborists often use compressed air drills for the application of fertilizers, possibly the most effective method of application for the home gardener is the punch bar method, the feeding needle, or spraying directly on the foliage. The feeding needles and foliage feeding have the decided advantage of the fertilizers being in solution when applied, and since plants do not use nutrients in a dry form, they are much more quickly available. While the fertilizers used in these needles are rather expensive in comparison with other methods they are easy to operate and their value in watering plants during severe dry periods cannot be underestimated.

The punch bar method requires a little more work. It is however very effective and while the fertilizers applied in dry form are not so quickly available, the results are much longer lasting and are recommended for feeding large shade trees. Holes may be punched with a crowbar, or any heavy rod, about 2 feet apart and from 15 to 20 inches deep. The feeding roots of most trees are located in the top 15 to 24 inches of soil and since most fertilizers, with the exception of nitrogen do not move about in the soil, it is necessary to place the fertilizer near the roots. These holes should not be punched in even rows, but staggered in order to furnish the nutrients to as much area as possible. The holes punched with a crowbar will be about 2 inches wide, and into these holes the dry fertilizer is poured. A funnel or paper cone may be used to direct the fertilizer into the holes — this not only makes sure the required amount is furnished, it avoids spilling and burning the lawn. The holes are then filled with either peat, leaf mold or top soil and the entire area well watered.

Foliage feeding or spraying fertilizers directly on the leaves of the plant does not give lasting results, but it is very effective when quick results are desired. Soluble fertilizers in the form of water soluble salts are available. These salts should be dissolved in water at the rate specified on the package. When applied to the foliage, the spray should be directly to the underside of the leaves since there is usually a greater number of pores, or stomata, located on the lower leaf surface and more of the solution is taken into the plant. If small shrubs are to be foliage fed, an ordinary flit gun will do nicely . . . for large trees such as maples, elms, beeches, etc., only high pressure sprayers can reach the leaves. When the solution drips from the foliage an adequate amount has been applied. The solution will not stick well on plants which have waxy leaves, such as roses, laurels, rhododendrons, pin oaks, etc., this may be overcome by adding about ½ teaspoon of Tide, Dreft, or other synthetic soaps to each 3 gallons of solution.

Most ornamentals grow best in a slightly acid soil — that is a pH range of 5.5 to 7.0. There are some however, which require a more acid soil. These include rhododendrons, azaleas, hemlocks, blueberries, mountain laurels, camellias, hollies, spruces, oxydendron, clethra, heathers and heaths, and bayberries. These plants should be fertilized with materials having either an acid or neutral reaction in the soil. There are several prepared fertilizers designed for these plants which are satisfactory. Hollytone is an example.

Unless a test for soil acidity determines that the pH of the soil has dropped below that which is best for the plant, it should not be fertilized with materials such as calcium nitrate, sodium nitrate, lime, or bonemeal. If the pH range has gone above that best for the plant it can be lowered by applying iron sulfate at the rates indicated below.

| present pH | pH desired | | |
|---|---|---|---|
| | 4-5 | 5-6 | 6-7 |
| 5-6 | 3 lbs/100 sq. ft. | . . . | add lime |
| 6-7 | 6 " " | 3 lbs. | . . . |
| 7-8 | 10 " " | 6 lbs. | 3 lbs. |

Aluminum sulfate may also be used to acidify soils. It should be used with care however, since it can easily injure plants. Aluminum sulfate should not be used on rhododendrons and azaleas. Sulfur is a safe and reliable acidifier and can be used on almost all plants. Although it takes a longer time to lower the acidity, the results are more lasting than either aluminum or iron sulfate; it is applied at about 1 pound per 100 square feet of soil area.

It is far easier to maintain acidity in naturally alkaline soils by incorporating organic materials such as acid peat, leafmold, etc., than to try to keep it within the lower range by constant application of chemicals.

The amount of calcium or lime necessary to raise the pH of the soil will vary with the type of soil. From 4 to 6 pounds per 100 square feet of soil area for a sandy loam, and from ¼ to ½ more than this amount for heavy clay soils.

Since so many fertilizer rates are for 100 square foot areas of soil the following comparisons may help in determining how much to use per plant. Mixed Fertilizers such as 5-10-5 may be applied at the following rates –

4 pounds per 100 sq ft. of soil = = approx. 2½ cups per plant spaced 5 ft. apart, or ½ cup spaced 2 ft. x 2 ft.

3 pounds per 100 sq. of soil = = 1½ cups per plant spaced 5 ft. apart, or 5 tablespoons spaced 2 ft. x 2 ft.

2 pounds per 100 sq. ft. of soil = = 1 cup per plant spaced 5 ft. apart, or 3 tablespoons spaced 2 ft. x 2 ft.

There are many different types and kinds of prepared fertilizers on the market – those especially prepared for roses, for trees and shrubs, for azaleas and rhododendrons, and for lawns. Most of these fertilizers are completely reliable and can safely be used on the plants they are designed for. However, one should beware of fantastic claims made by companies to the effect that their fertilizer will make diseased plants healthy, produce many times a normal rate of growth, etc. Plants can safely use a specific amount of nutrient elements, and used in correct combination with proper soil, light, and temperature requirements, will thrive. Satisfactory results above those that are normal for the plant are seldom obtained and should not be expected.

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# Arboretum Activities

*(Continued from Page 18)*

Among the plants most badly damaged were some of the older conifers, especially *Thuja* and *Chamaecyparis*. One very handsome *Abies Vietchii* was almost completely ruined, as was a fine *Picea Maximowiczii*. Many of the smaller conifers as well as most of our boxwood, escaped branches had been bound together last autumn.

By some almost miraculous quirk our superb Atlas Cedars suffered a minimum of damage as did most of our larger pines. The hollies, on the other hand, were among the most badly hit and several of them will take many years to recover from the breakage of their leaders.

Among deciduous trees the flowering dogwoods were the most severely broken, yet already they have made new growth and give promise of rapid recovery. The hawthorns and sourgums were also badly injured.

Two of our worst victims were a magnificent Chinese Elm, *Ulmus parvifolia* and a fine old Siberian Elm, *U. pumila*. These two trees have required many hours of careful pruning and only time will reveal whether they can ever regain their handsome shapes.

Although beaten horizontal by the snow, most of our thousands of azaleas seem to have come through without permanent injury. The same may be said for most of our other low shrubs, although one Beauty Bush *(Kolkwitzia)* was practically decimated.

Damage to the greenhouses was fortunately slight, with the exception of a section of the palm house which lost some glass. The newly renovated fernery came through unscathed.

Warm praise is due the members of our staff who worked with unremitting energy to clean up the damage and restore the grounds to a condition of apparent normalcy. Much work still remains to be done, especially in the tops of the taller trees and in straightening up the smaller

conifers, but few visitors to the grounds today would realize that the Arboretum had been subjected to one of the worst storms in its history.

### Seeds Received

In the last issue of the Bulletin reference was made to our practice of exchanging seeds of woody plants with other institutions in this country and abroad. At that time we mentioned the number of requests we had received for items on our own list, but said little about the benefits which we in turn derive from such an exchange.

It is now possible to state that during the last few months we have received seeds of over 550 species of trees and shrubs which we requested from other botanical gardens and arboreta. About 100 of these came from institutions in this country; the rest were received from gardens in the British Isles, Czeckslovakia, France, Germany, Hungary, Italy, Japan, Yugoslavia, Poland, Portugal, Russia, Spain and Switzerland.

According to their individual requirements these seeds will be subjected to cold, treated with acid or planted directly in flats. Following germination the young seedlings will be placed in a cool house or in the cold frame for a year or two before being transferred to the nursery where they will be tested for hardiness.

As this practice will be repeated in future years the increase in the Arboretum's representation of woody species will be considerable.

J. M. F. Jr.

# Gardel—A Good Sign of the Times

Patricia Allison

Gardel is the name of one of the vigorous trade associations in our area, the Garden Supply Dealers of Delaware Valley. The formation and activities of such organizations in various parts of the United States represent the climax of the many transformations that have accompanied the movement of city dwellers to the suburbs.

The first of these transformations was probably the startling personal realization that home no longer extended from wall to wall, but from lot line to lot line. Next came the "plant furnishings" of the outdoor portion of the home and, of course, the increase in numbers of suburban nurseries and varieties of available plants. Caring for these outdoor furnishings soon consumed the interest of not only the homeowner in charge, but big business as well. Never before had there been such demand for tools; never before had agricultural industries taken it upon themselves to pass on their products and information to such "small operators" as homeowners; and never before had there been such a prodigious demand for information.

Consider the tool problems. The power mower, once the pride of gardening staffs of large estates, has undergone special redesign a hundred times over, and is now as ordinary outside the home as the vacuum sweeper is inside. The same sort of special designing, production, and marketing have brought sprayers into common usage, and have brought high quality hand tools of reasonable price.

Consider the pesticide problems. Not long ago the selection of materials for agricultural and home use alike was limited. It was agriculture that first received the benefits of organic chemical research, and for a time it was agriculture alone that was supplied with the large-package products. Now many of these same materials, with recommendations for small scale use, are available at garden suppliers, at hardware stores, and even in grocery stores.

Consider now the information problem. Who can tell us what "plant furniture" to buy, when to plant it and where to plant it. Who can guide us in our selection of new maintenance equipment and its use. Who can tell us what our insect problems are and thread through the maze of brand names to the correct material to use in solving them. Certainly not the same man who sells soap powder and soup, and probably not the same man who supplies us hinges and hammers.

First, there are newspapers, magazines, garden books, and government pamphlets to consult. Agricultural extension specialists spend a large proportion of their time with plant problems of the individual taxpayer. Industry has cooperated with clear directions for use of their products. In addition to these sources of information there is the conscientious specialist in garden supplies. Many of these men have realized that they must not confine themselves entirely to the art and technique of selling. In addition, they must supply information and service.

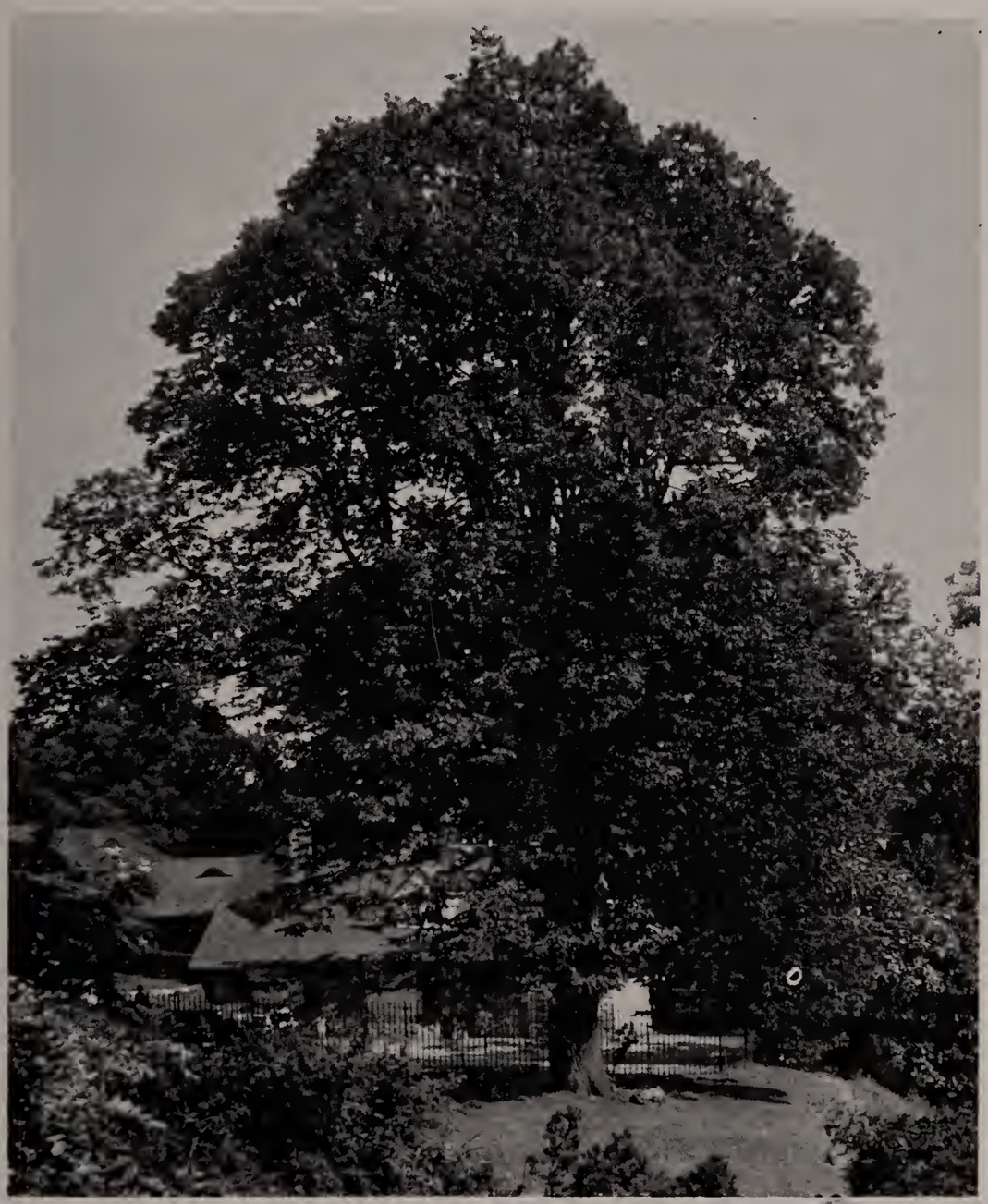
Gardel is a nearby group of such individuals who attempt to keep up with recent developments and be familiar with the fundamentals of all phases of gardening. They contribute both funds and time in these efforts. The associates meet regularly to listen to lectures by professional garden specialists and industrial representatives, and to pool their knowledge about customer questions.

Being able to provide service to customers has once again, refreshingly, become part of the modern scene.

# Morris Arboretum Bulletin

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*Tilia americana*

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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# Arboretum Activities

## Open House

For the third successive year our Open House for Associates, held on Sunday, May 18, was favored by superb weather. Over 200 associates and their friends took advantage of this occasion to visit the Arboretum, participate in tours of the grounds and partake of refreshments.

Instead of a single general tour of the Arboretum, as offered in the past, we this year arranged for a series of tours under expert guides. It was thus possible for our visitors to concentrate on azaleas, which were then at their height, to inspect the newly established Medicinal Garden, to view the recently renovated Fernery or to be initiated into the mysteries of bee-keeping by a trip to the Langstroth Bee Garden.

A few hardy souls "signed-up" for all of these tours and reported that they had spent a memorable afternoon with us.

*(Continued on Page 48)*

# The Cultivated Lindens

Hui-Lin Li

The Lindens or Basswoods belong to the genus *Tilia*, a member of the Linden Family or Tiliaceae. Although this family is essentially tropical, *Tilia* itself is confined to the temperate regions of the Northern Hemisphere and is represented by some thirty species in Europe, Asia and North America. All of the species are trees with alternate, simple, usually cordate leaves and flower and fruit clusters borne on large leaf-like bracts, the latter being a very unusual feature among flowering plants. (Fig. 26) [1]



Fig. 26 Fruiting clusters of *Tilia tomentosa*

The Lindens are handsome trees with beautiful foliage and are widely planted as ornamental or shade trees. The continuous falling of the fruit bracts, however, makes them somewhat untidy. Besides being popular ornamental trees, the Linden possesses several characteristics which have been of great value to mankind since very ancient times. One is their importance as a source of honey, for their flowers are very fragrant and rich in nectar. Another is the use of the wood for carvings and utensil-making, as it is essentially soft, straight-grained and easily worked. Still another is the utility of the inner bark or bast, which is fibrous and can be used for the manufacture of cords or fishing nets.

The value of the soft wood in making carvings and the bast for making cords was known not only to the ancient Europeans and Asians, each employing separately their own native species, but was also discovered independently by the American Indians who utilized the native American species. The various uses in the different lands will later be discussed in greater detail.

## Common Names

The common names of *Tilia* are many and varied. In the United States, the various species are usually called Linden or Basswood (Bastwood), but sometimes the trees are also known as Bee-Tree or in the South as Linn. The wood, because of its pale color, is commonly known in America as Whitewood, a name also applied to the wood of the Tulip-tree, *Liriodendron*. The most commonly used name of the trees in Europe is Lime, probably derived from the old Anglo-Saxon name Lind. Linde is the common name used by the Germans and the Dutch. The classical Roman name of the tree was Tilia. This becomes Tilleul in French, Tiglio in Italian and Tilio in Spanish. Linden is especially the favorite of the Germans and it is often mentioned in their folklore and early poetry.

In eastern Asia the classical name given to the trees by the ancient Chinese is Tuan. Many colloquial names are locally applied to the various species.

## European Species

There are three species of *Tilia* commonly cultivated in most countries of Europe. Two of the species have been in cultivation since very ancient times: *Tilia platyphyllos*, the Large-leaved Linden, with large, hairy leaves and large flower clusters, (Fig. 27) and *Tilia cordata*, the Small-leaved Linden, with smaller and hairless leaves and smaller flower clusters. A third, *Tilia europea*, the Common Linden, now more commonly planted than the other two species, has characters intermediate between the two and is in all probability a hybrid between them. (Fig. 28)

The Lindens were known to the Greeks and Romans and were mentioned by Theophrastus, Pliny, and many other early writers. The use of the tree as a honey source made it a favorite

[1]) Photographs by Chester E. Pancoast from trees growing in the Morris Arboretum.

among early people. The tree, according to Theophrastus, is of two sexes, totally different in forms, referring probably to the two large-leaved and small-leaved species (Loudon 1838). It was much esteemed by the Romans as a shade tree. According to Pliny, the wood was employed for numerous uses. Virgil mentions especially the quality of yokes made from its wood.

The early classification of the European species was somewhat confusing, and a very long list of synonyms is involved. The three Lindens were recognized by Linnaeus in 1753, as representing a single species, *Tilia europaea* with eight different varieties.

The large-leaved Linden, *T. platyphyllos,* is widely distributed through central and southern Europe, and is largely a southern tree, occurring only in the southern countries. It has been in cultivation longer and has produced more varieties than the other species, among them fastigiate and laciniate-leaved forms. A specimen of the latter (var. *laciniata* (Loud.) K. Koch) may be seen at the Arboretum. (Fig. 29).

The small-leaved Linden, *T. cordata,* a less variable species, is the common Linden of northern Europe although it is also found in the south especially at high elevations. Though it is common and widely distributed, it is less frequently planted in central Europe than the other Lindens.



Fig. 27 *Tilia platyphyllos*

The common Linden, *T. europaea* (*T. vulgaris*), is the largest of the European Lindens. As mentioned before, it has characters intermediate between the two other species. Its hybrid origin is further indicated by the fact that although it is the most widely planted species in Europe, it is almost unknown in the wild (Sargent 1889, Elwes & Henry 1912). Its probable hybrid origin was early recognized by such authors as Palmstruch and Venus, who called it *T. intermedia* in 1802, and Bechstein, who called it *T. hybrida* in 1810. In 1909, in his monograph of the genus *Tilia,* V. Engler definitely identified it as a hybrid between *T. platyphyllos* and *T. cordata.* (Fig. 30).

Just when the common Linden first appeared in cultivation cannot be ascertained. It has been cultivated as a park and avenue tree for at least three and a half centuries (Sargent 1889). In the early years it was largely propagated in Dutch nurseries and was often known as *"Tilia hollandica"* or "Hollandische Linde." It is the tree that gives its name to the most famous street in Berlin. This is also the Lime so often seen in English parks and gardens. The most famous avenue there is the one in Trinity College at Cambridge.

Besides these three Lindens which are widely planted in Europe, there are three other species: *T. tomentosa, T. petiolaris* and *T. dasystyla,* which grow in the southeastern part of the continent as well as in western Asia. *T. tomentosa,* the Silver Linden, is a tall ornamental tree with silvery leaves. (Fig. 31).

*T. petiolaris,* when mature, is a large tree with pendent lower branches; its leaves are whitish-tomentose on the lower surfaces. A fine specimen of this species is to be found on the grounds of the Arboretum. (Fig. 32)

## Uses of Linden in Europe

Lindens have been valued since ancient times for their honey. The honey produced from the flowers is universally considered superior to all other kinds in quality. Linden oil, obtained by distilling the flowers, has a pleasant odor and is used in perfumery.

The wood of Linden is known for its easy working quality, and besides many other uses, is highly prized for carving. Many of the fine carvings in old buildings in England as well as on the European continent are of this wood. In



Fig. 28 *Tilia europaea*

ancient times, it was extensively employed for making all kinds of utensils.

The most important value of Lindens, especially in the northern part of Europe, was for the making of ropes, mats, shoes, fishing nets, and similar articles from the inner bark or bast. This use was of great importance to peasants in former times, but even today, ropes and mats are still being made from Linden bast in some parts of northern Europe.

Lindens have long been considered as among the most favorite avenue trees in Europe. The fashion of planting these was made popular by French landscape gardeners in the latter half of the seventeenth century, at a period when the formal style of gardening prevailed. Avenues of Linden trees were an essential feature in every park and town in central and northern Europe. The ability of Lindens to thrive under repeated severe pruning makes them especially fit for formal gardens. Their graceful, free habit renders them desirable as lawn and street trees.

Mention may be made here of the "honey dew," somewhat viscid, sugary dots frequently found sprinkled on the upper leaf surface of the Common Linden and related species. Much has been written on this subject. Some authors believe this is an excretion caused by the presence of aphids, but most probably it is a direct exudation from the leaves due to excessive transpiration under intense sunlight (Elwes & Henry 1913). After the honey dew dries and thickens, it becomes the site of growth of certain fungi resulting in the blackened dots commonly present on the leaves in late summer and fall.

### Eastern Asiatic Species

Over two-thirds of the species of the genus *Tilia* grow in eastern Asia. There are about twenty-one species in China, one in Korea, and three in Japan. The species are mostly tall trees of the mountain forests, and only a few are in cultivation in their native countries. The most widely cultivated species in northern China is *Tilia mandshurica,* the Manchurian Linden. The most frequently grown species in eastern China is *T. Miqueliana,* which is also commonly planted in Japan. A few other species are occasionally planted, including *Tilia Tuan* of central China, the specific epithet given by the Polish botanist Szyszylowicz being the classical Chinese name of Linden trees.

In northern China, the species of *Tilia* are considered valuable not only as shade and ornamental trees but also for their wood and bark. The wood is used for manufacturing various kinds of utensils, for carving and for making printing blocks. The bark is used extensively for making ropes and other coarse weavings such as mats and sandals. Large quantities of the fibers are collected by the farmers in northern China for these purposes.

Many of the wild species of *Tilia* have been introduced into cultivation in the West by modern explorers, but these are still limited to botanical gardens and arboretums.

### Lindens as Buddhists' Trees

An interesting feature of Lindens in eastern Asia is the religious significance attached to them by the Buddhist monks. This is not an ancient attribute, but one which was deliberately accorded to it by these priests perhaps some five or six hundred years ago, after Buddhism, introduced from India several hundred years earlier, had become firmly established in China and very popular among the general public.

The Buddhists in China call the Linden p'u t'i shu or bodhi tree, a name originally applied to *Ficus religiosa,* a tropical tree. According to the Buddhist legend it was under a tree of *Ficus religiosa* that understanding came to the Buddha Gautama, in 528 B. C., after eight years of meditation. The tree was named bohdidruma in Sans-



Fig. 29 *Tilia platyphyllos* var. *laciniata*

krit, meaning the tree of enlightment (Burkhill 1946). In later years cuttings from this sacred tree were taken and planted in different parts of India and Ceylon; and from these trees cuttings were also brought to southern China.

In northern China, however, this tropical tree is not hardy. In the words of Burkhill, the Buddhists "in a kind of desperation," transferred the name to *Tilia*. He thinks there is no similarity between the two to justify such a transfer. However, I believe the basis for such a transfer may be in part due to the slight resemblance in the leaves, and in part due to the unique fruit clusters of the Lindens. The leaves of both are broad at the base with a cuspidate tip, giving them more or less a similar outline. The fruits of Lindens are of course very different from those of *Ficus*, but they are distinctive in appearance, resembling somewhat the fruits of another plant, *Sapindus mukrossia*, which bears fruits long attributed by the Taoist priests as possessing exorcizing power. This was called p'u t'i tze or bodhi fruit by the Buddhists in later times. (Chen 1946). Thus the transference of the name "bodhi tree" is made actually to two plants, one for the leaves and another for the fruit.

The species of *Tilia* cultivated by the Buddhists on temple grounds as bodhi trees are two: *T. mandshurica* in northern China and *T. Miqueliana* in eastern China. The latter is rarely found in the wild and is quite variable, thus suggesting a possible hybrid origin. It was introduced into Japan and is widely planted there mostly on temple grounds. Although Japan has several native species of *Tilia*, this introduced species is the one commonly cultivated. It bears the name bodai, Japanese for bodhi (Makino 1951), and is traditionally believed to have been introduced from China by a Buddhist priest about the year 1190 A.D. (Elwes & Henry 1912).

## American Species

There are about five species in North America. The most wide-spread is *T. americana*, the American Linden, which has a natural range in the eastern part of the continent extending from Canada in the north, southward to Alabama and westward to Texas and North Dakota. (Sargent 1891). It is the most commonly cultivated native species, frequently planted as an avenue tree.

The American Linden is one of the earliest cultivated trees in North America. Its first cultivation must have been in the first half of the eighteenth century. Rehder (1940) gives the date "Intr. 1752", which is misleading. This is the date of cultivation by Miller in England (Loudon 1838). Actually its first introduction into England was much earlier, for in the *London Catalogue of Trees*, 1730, there is mentioned: "Tilia, with leaf more longly mucronate. Seeds sent from Carolina by Catesby in 1726, hardy, and may be propagated as other limes." (Elwes & Henry 1913).

In Europe, several varieties with different leaf-forms have been selected from cultivated

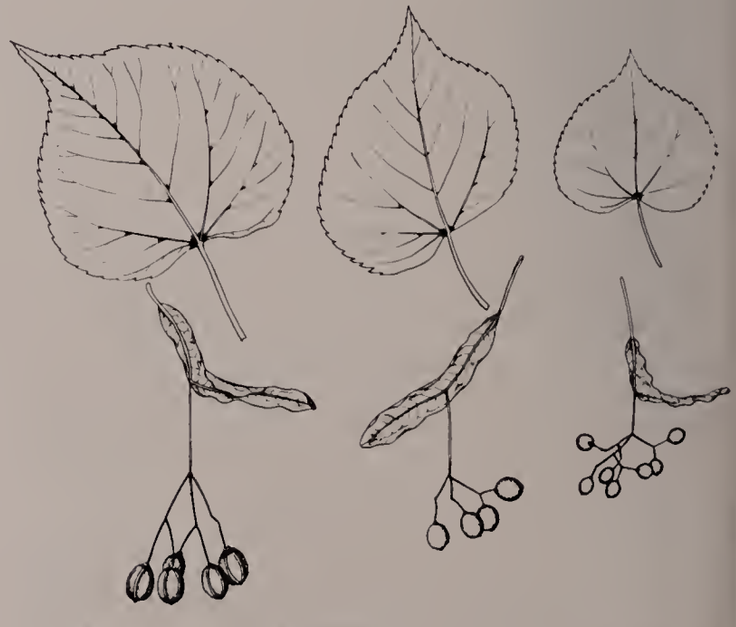


Fig. 30 Left: *Tilia platyphyllos;* middle: *T. europaea;* right: *T. cordata.*



Fig. 31 *Tilia tomentosa*

plants: 'ampelophylla'—with large coarsely and irregularly dentate leaves; 'dentata'—with more sharply often nearly double dentate leaves; and 'macrophylla'—with larger leaves than the typical form. In America, there is now in cultivation, a pyramidal form 'fastigiata', with ascending branches.

The other native American species are less commonly cultivated, *Tilia heterophylla,* together with the var. *Michauxii,* is also widely distributed in the eastern United States. The other species are more restricted in their ranges, *T. neglecta* of eastern North America, *T. monticola* of the Appalachian Mountains, and *T. floridana* of the southern United States, Incidentally it may be mentioned that there are widely different views among botanists regarding the classification of American Lindens. Some recognize only three species, and others as many as fifteen species.

### Uses of Lindens in America

The American Indians, before the arrival of Europeans, independently made use of the special qualities of Lindens, namely, the soft easily worked wood, and the tough fibrous inner bark or bast. The bast was used for making cordage and mattings. The wood was much used for making household wares. Longfellow narrates that all the bowls at Hiawatha's wedding were made of basswood, smoothly polished.

The wood, known also as whitewood, is light brown in color. It is now used in America in the manufacturing of wooden wares, cheap furniture and similar objects. It is also used for making paper pulp, but the quick decomposition of the sap make it unfit for white paper (Sargent 1891).

### European Species in America

The common Linden and some other species of Europe are often cultivated in America, either as avenue trees or in botanical gardens. The American species, actually, do better than European trees, since they are native and therefore more suitable to the climate. But European Lindens are still being widely planted as street or lawn trees in this country.

Many of the larger eastern cities in North America have a Linden Avenue and often it is the European Common Linden that lines the



Fig. 32 *Tilia petiolaris*

street. These European Lindens were doubtless among the very first trees brought to the New World by the early colonists. There are, for instance, massive trees of the Common Linden planted along the streets at Plymouth, Mass.

Lindens are subject to the attacks of many insects, which sometimes disfigure the trees by devouring the foliage or even destroy the trees by boring into the trunks. All the American and European species are susceptible to such injuries, but trees growing in richer soils often fare better and are less affected than native species.

### Hybrids

It was mentioned above that the Common Linden (*T. europaea*) is most probably a hybrid between the two common European species. The species in this genus seem to be able to hybridize freely. With the introduction of American trees to Europe, there have arisen in cultivation a number of specimens showing intermediate characters between some of the American species and the various European ones. A list of such putative hybrids on record is given below; their parentage is often conjectural. These were all selected from among cultivated plants in Europe in the nineteenth century, and most of them are not in cultivation in America.

*T.* × *euchlora* (*T. cordata* × *dasystyla?*) Originated before 1860 in Russia.

*T.* × *flaccida* (*T. americana* × *platyphyllos?*) Originated before 1834 in France.

*T.* × *flavescens* (*T. americana* × *cordata?*) Originated before 1836 in Germany.

*T.* × *Juranyana* (*T. cordata* × *tomentosa?*) Originated before 1834 in Hungary.

*T.* × *Moltkei* (*T. americana* × *petiolaris?*) Originated before 1880 in Germany.

*T.* × *orbicularis* (*T. euchlora* × *petiolaris?*) Originated about 1870 in France.

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# Maple Check List

Published under the auspices of the American Association of Botanical Gardens and Arboretums, there appeared late in August Brian O. Mulligan's long-awaited annotated check list entitled, "Maples Cultivated in the United States and Canada."

Dr. Mulligan, who is Director of the University of Washington Arboretum at Seattle, has labored long and diligently to make this volume as accurate and comprehensive as possible. He has been aided by a Publications Committee and by the directors of more than a score of botanical gardens and arboreta in this country and Canada who have supplied data concerning the maples cultivated in their own institutions. As a result, this compilation will prove of inestimable value to all who are interested in the occurrence of this large and important genus in the gardens and parks of temperate North America.

The present work comprises 56 pages, of which eight are devoted to illustrations. In an introductory section the author discusses the botanical history of the genus *Acer*. This is followed by a brief account of the geographic distribution of some 150 species and an outline of their presently accepted botanical classification.

The main body of the work is devoted to the check list of cultivated maples. This includes some 70 species and numerous varieties, forms, cultivars and hybrids. (In *A. palmatum* alone more than 70 subspecific taxa are listed.) Each entry is followed by symbols indicating the major gardens and arboreta in which it may be found growing. Information is also given concerning the country of origin, the original discoverer, and the date and place of introduction into cultivation.

Additional sections, which might better have been designated as appendices, are concerned with such special topics as the uses of Maples as large shade trees, as small ornamental trees and as fall color subjects.

A valuable feature of the work is a chapter on the Propagation of Maples, contributed by Roger G. Coggeshall, formerly propagator at the Arnold Arboretum.

Copies of this check list may be obtained from Mr. Carl Fenninger, Secretary of the A.A.B.G.A., Box 216, Lima, Delaware County, Penna. The price is $2.00 per volume, with discounts for lots of more than ten.

J. M. F., Jr.

# Characteristics and Identification of the Soft Pines Cultivated in the Philadelphia Area

Jonathan W. Wright

(*Continued from page 30*)

## Sources of Seed and Nursery Stock

Most species growing in Philadelphia are now coning. The larger Himalayan white and limber pine trees sometimes produce hundreds of cones. However, there are three reasons why the use of this Philadelphia grown seed (or for that matter seed collected in any arboretum or park) should be discouraged. First, some species such as eastern white and Himalayan white pine produce mostly empty seed because of some peculiarity in the Philadelphia climate. Second, such species as Swiss stone, Japanese white, lacebark, and Korean white pines are too rare to be adequately cross pollinated and for that reason set mostly empty seeds. One year a bushel of cones from the Morris Arboretum's large lacebark pine yielded only 32 filled seeds, and most of those were probably selfed. Third, isolated Philadelphia specimens of western white, Macedonian white, and Mexican white pines regularly produce fertile seeds, but this seed is almost certainly the result of hybridization with eastern white pine. It is valuable for some purposes, but will not yield true-to-name trees.

Seed should be collected from natural stands and should be labelled as to its geographic origin. Some of the larger seed dealers regularly stock or can obtain such seed of all species except those whose native ranges are behind the Iron Curtain.

Eastern white pine is a common item in most forestry and ornamental nurseries. Himalayan white and limber pines have been stocked for short times by Philadelphia area nurseries but at the present time they and the other exotics can be obtained only from rare plant nurseries scattered around the country.

## Propagation of White Pines

White pines are most easily propagated from seed. The seed can be sown directly in shaded, well-watered outdoor nursery frames. The seedlings are resistant to mineral spirits, and can be weeded by being lightly sprayed with a suitable petroleum compound such as "Varsol". Or, the weeds can be kept down by covering the seeds with sawdust which will reduce damping off losses and maintain soil moisture.

In forestry practice we usually outplant naked-rooted eastern white pine seedlings that are 4 to 8 inches tall and 2 to 4 years old. With proper ground preparation (and watering during exceptionally dry seasons) the percentage survival can be as high as 95 percent. However, I usually prefer seedlings that have been transplanted once and are about one foot tall. They are not too large to be moved naked-rooted and are easily visible after outplanting.

In the tree breeding work at the Northeastern Forest Experiment Station we encountered special difficulties with certain species. Mice ate the seeds of the large-seeded Korean white pine in preference to those of other species present in the greenhouse or nursery. Sugar pine grew vigorously for two years but failed to survive transplanting. This was probably related to the fact that the seedlings developed a single taproot and almost no fibrous roots; the seedlings should probably be grown in large, deep pots and transferred to their permanent locations when only two years old. Seedlings of the large-seeded Japanese white and dwarf stone pine started off rapidly but grew little during the next three years, possibly because of lack of mycorrhizae.

There is no satisfactory method of rooting cuttings taken from old white pine trees. Peculiarly, single bundles of needles can be rooted but cannot be induced to form terminal buds. Cuttings made from young seedlings can be rooted rather easily in a greenhouse bench.

Air layering seems to offer an easy method of vegetatively propagating small numbers of trees. The treatment consists of wounding a small branch, dusting the wound with rooting powder, surrounding the branch with a large wad of moist sphagnum, covering the sphagnum *tightly* with a sheet of waterproof plastic, and sealing the branch-plastic joints to prevent water loss. One of the biggest secrets of success is to wait — 18 months if necessary — until roots are visible through the plastic. Premature inspection results in drying out and loss of roots that are just starting.

The white pines are easily grafted by the usual methods. The grafts are most successful if

the understocks are potted approximately one year beforehand and if the newly made grafts are kept in a moist chamber until the union is complete. The resin poses no special problem; nor does understock, within wide limits. The Arnold Arboretum in Boston has an old lacebark pine grafted onto eastern white pine. The graft line is still visible but the scion seems to be growing as vigorously as if it were on its own roots. One Canadian worker reports that white pines remain alive for at least a few years when grafted onto Scotch pine seedlings. However, chances of success are always best if the scion and understock are similar genetically.

In recent years many tree breeders have tried open field grafting. This seems to be most successful if the grafts are made on the new candles. In open field grafting it is essential that the grafts be protected from drying out by waterproof coverings and that they be shaded by paper bags or a muslin screen. If the scionwood is taken from the upper, flowering portion of a tree, it may continue to flower for several years after the graft is made. Thus, it is possible to obtain 4- to 5-foot-tall trees that are loaded with cones.

### Insect and Disease Pests

White pine blister rust *(Cronartium ribicola* Fischer) is the most serious white pine disease. It is a native disease in Asia whence it was introduced into Europe and America on live trees. Most of the Old World white pines are resistant or immune but the important New World species are susceptible. If this disease had been allowed to go unchecked it might have destroyed many large areas of eastern white pine, and would almost certainly eliminate the extremely susceptible western white pine. As it is, the western white pine is being saved only in the most productive areas where economical control is feasible.

Two features of the life history of the blister rust fungus make control of this disease possible. First, it has two alternate hosts — *Ribes* (currants and gooseberries) and *Pinus*. Second, it can spread only a few hundred feet from *Ribes* to *Pinus* although it can spread for miles from *Pinus* to *Ribes*. Thus, white pine stands can be protected by eradication of the *Ribes*.

It is encouraging to note that the *Ribes*-eradication operations have been successful in the Northeast, and that one finds only an occasional blister rust canker. Constant vigilance is necessary, and the planting of the relatively unimportant gooseberries and currants should be discouraged.

The second most important pest — actually the most important in the Northeast — is in the white pine weevil *(Pissodes strobi* (Peck) ). This insect kills the leader and causes the tree to grow crooked. It does not endanger the white pine population as a whole, but causes a great loss of lumber values. Fortunately, the weevil can be controlled easily by spraying at the proper time with lead arsenate or DDT. Also, some species such as western white pine are much more resistant than is the eastern white pine.

Cone insects *(Conophthorus coniperda* (Schw.) and *Dioryctria* spp.) are a nuisance to the tree breeder. I have often pollinated 100 or 200 female strobili per tree in Philadelphia and the Pocono Mountains, only to find all but three or four dead before the next spring. These cone insects are responsible for most of the periodicity in white pine seed years and the low number of natural seedlings in many forest areas.

Occasionally one sees a slow-growing, yellow-foliaged eastern white pine. This condition may persist for years. Its cause it not yet known. Nor is the cause known for the sudden death of occasional scattered trees that are apparently healthy one year and brown the next.

In the northern part of Idaho western white pine suffers from a serious disease called pole blight. Its cause is unknown. Its symptoms are a yellowing of the foliage, reduction in growth rate, bark lesions, and death. This pole blight has not been observed in the Northeast.

One forest planting of Macedonian white pine in upstate New York has a high incidence of needle cast or needle browning caused by the fungus *Hypoderma desmazierii* Duby. Some of the trees seem to be genetically resistant to the disease because they are entirely green in spite of having their branches intermingled with branches of severely infested specimens. The disease was present for at least two years but has not caused a noticeable reduction in growth rate.

These are the most serious of the white pine pests. None is particularly troublesome in Philadelphia, and the home owner in this area can plan on planting white pines that should remain relatively healthy.

### Soil Preferences

The eastern white pine grows best on a deep, rich, moderately well-drained soil. However, it will survive on a wider range of soil texture and drainage conditions than most other tree species. For example, it will grow slowly for years under almost swamp conditions, and thrives on deep sands.

In one New York planting eastern and western white pine were planted side by side down a hillside and into a swamp. Both species did well on the hillside but only the eastern white pine survived in the swamp.

For the other exotic species we have almost no data on soil preference. Most have done well on deep, rich, moderately well-drained clay or clay-loam soils but have not been tested on other soils.

Until more information is available it would be best to confine the planting of the doubtfully hardy Armand, Mexican white, Himalayan white and sugar pines to protected sites at relatively low elevations. On the other hand, hardiness will probably not be a factor in the success of western white, Korean white, and Swiss stone pines in Pennsylvania.


### Acknowledgments

I wish to express my thanks to the many members of the staffs of the Northeastern Forest Experiment Station and the Morris Arboretum who have cooperated in the tree breeding research carried on by the Station. Special thanks are due E.J. Schreiner, John M. Fogg, Jr., and H.L. Li.

Liberal use was made of the facilities of Westtown School, Westtown, Pennsylvania; Haverford College, Haverford, Pennsylvania; Highland and Durand Eastman Parks, Rochester, New York; and the New York State Division of Forests. Without the foresight of the men in charge of these agencies, the performance of these white pine exotics would be much less well known than it is today.

I also wish to acknowledge the assistance of Karl Dressel, Donald P. Watson, Donald P. White, and John L. Arend, who critically read the manuscript and offered valuable suggestions.


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# Survey of Unusual Growing Season, 1958


Patricia Allison


The drought of 1957 wore on and on and on. Day by day the havoc increased, first among the dogwoods and rhododendrons, then even among the tougher trees and shrubs. Every possible step was taken to protect each victim as the soil continued to parch. Even then fears were born for the safety of trees and shrubs in 1958, for the effects of prolonged droughts often are revealed months or years afterwards, just as the effects of transplanting may not appear until subsequent seasons. Then came the brilliant fall and finally the blessed moisture of a winter of relatively mild temperatures. Fears had subsided a trifle when the calamity of March snow descended. Its own chronicle of destruction has already been related in the Bulletin. As with drought, however, there is hidden damage by such a storm—branches that do not snap but bend, overburdened, splitting in hidden parts before the weight is removed. The removal of the obvious wreckage from trees already weakened by drought was a sickening task. It remained to be seen what the spring and summer would bring.

The over-all picture, fortunately, has been good, for it has rained and rained—perfect for the recuperation of root systems damaged by drought or the wrenching of winter snows, but somewhat less than perfect in other regards. Without the abundant rainfall, there surely would have been additional losses from the drought. With the frequent rainfalls, and the interspersed warm, bright, dry days, came many peculiar effects, and not a few damaging ones. Some were surely due to the unusual weather history the plants had experienced, others to the pests and pathogens that overwintered in abundance and were able to attack weakened hosts in force. Here are a few examples from many.

Scorch of foliage was common, especially on beech and thin-leaved maples. Leaves and twigs remained in a lush and succulent state, thanks to the abundant moisture and overcast days. Such tissue was extremely susceptible to injury from the occasional hot drying winds on bright days, as well as to certain pathogens.

Two reports of strange goings on of dogwoods were received. Those that survived the drought and storm put on their usual display of white and pink during the first half of May. This display had developed gradually as the chlorophyll

disappeared from the bracts ("petals") around the flowers during the last week of April.

The strange reports were of dogwood *leaves* which had undergone the same process. Twigs were brought in that had a series of green leaves, then a few white ones, and finally, at the tip, normal young green leaves again. The story was repeated with a pink variety.

Even the hardy Ginkgo had its troubles. Two reports were received of excessive defoliation during late May. No evidence of pest or pathogen was found among the trees examined, and the leaf-fall stopped in June.

Magnolias, known to bloom twice during an occasional season, really outdid themselves this year. In mid July a number of species and varieties were in bloom again.

That the spring and summer weather favored certain plant pathogens became abundantly clear early in the season. A common inquiry was, "Why are the plane trees so late in leafing out this season?" Actually, they were not late at all. Before the leaves were fully expanded, as early as May 24, many trees were defoliated by the anthracnose fungus. The leaves that seemed so late in arriving were actually a second set, often arising from buds well within the wood of twigs. Nor did the fungus stop there. Many of the new leaves were lost as rainy periods provided ideal conditions for sporulation and dissemination of the pathogen. Some leaf fall was occurring throughout July. The same fungus caused damage to oaks as well. Leaf fall has continued through August.

Other fungi have been extremely active. Turf diseases have been particularly severe this season. Other groundcovers such as *Pachysandra* and *Vinca* were found in serious condition at some locations in mid April and mid May, respectively. *Leucothoe* was well-spotted with its common leaf spot fungus by May 15.

Although many powdery mildews are thought of as late-season arrivals, 1958 was a banner year. Well-advanced rose powdery mildew was observed May 17. Related fungi were common on *Aesculus, Platanus,* and dozens of other hosts. Powdery mildew, usually more of a nuisance than a danger to lilacs, caused severe damage to many varieties this year.

The story could be repeated with insect pests. The usual array was present in abundance. In addition, trees weakened by drought or storm fell prey to species that are usually not so lethal. Two specimens of *Pinus Cembra* were killed in a very short time by several twig and trunk beetles of this type. Gall insects were especially common, and were destructive because of their abundance on some oak species examined.

Because wet weather would not allow movement of the equipment, dormant sprays could not be applied to trees and shrubs before the rapid development of foliage in the sudden warmth of early spring. Judging from the activities of insects and of fungi this season, such sprays will be extremely important next spring.

So it goes—the effects of one year carrying over to the next. Let's hope that there are no immediate encores to the drought of '57 or the winter of '58.

# Arboretum Activities

*(Continued from Page 38)*

### Medicinal Garden

Mention has been made before in these pages of the Founder's Fund Award of the Garden Club of America, which was given to the Morris Arboretum for the purpose of establishing a garden of Medicinal plants. This garden was officially opened on the occasion of our Open House on May 18 and attracted considerable attention. (Fig. 33).

Located on a slope just below the Rose Garden, this small beginning of a living collection of drug plants, has continued to intrigue visitors to the Arboretum during the summer months.

Here one may see many of the plants which over the centuries have formed the basis of the Materia Medica of many countries as well as a number of species which have come into prominence only in recent years.

Hardy forms such as Digitalis, Aconite, Cascara, Valerian and Witch Hazel will be found growing side by side with tender tropical species like Quinine, Eucalyptus, Nux Vomica and the Rauwolfias. Altogether some 60 species make up the present exhibit.

An early issue of the Bulletin will carry a fuller account of this garden with a complete list of species and their medicinal uses.

### Plant Distribution

As announced in a previous issue, our annual distribution of plants to our Associates which has heretofore been held in October will, by popular consent, be deferred until next Spring. We are convinced that this is a more satisfactory time of year to distribute plants than autumn, especially to those of our associates who do not possess cold frames.



Fig. 33 Medicinal Plant Garden

A future issue of the Bulletin will carry an announcement of the date of the next distribution and each associate will, as in the past, receive a notice of this event which will probably be scheduled for late April or early May.

### The Summer Course

The summer course dealing with the indentification of Woody Plants, which was instituted in 1955, was given again at the Arboretum this year. The course was one of those presented under the aegis of the Summer School of the University of Pennsylvania and lasted for six weeks, from June 30 to August 8.

The principal objective of this course is to acquaint the student with the more important ornamental trees and shrubs, both native and exotic, which are hardy in the Philadelphia area. The rich collections of the Arboretum make it an ideal place at which to conduct such studies.

Of the twenty-one students enrolled five were high school teachers of science who had been awarded scholarships for summer work by the Esso Education Foundation. Several other teachers in the class held University Summer School scholarships. Seven members of the group were graduate students in the University's Division of Landscape Architecture who took the course in order to become familiar with the rich resources of plant materials which may be used in design.

### The Recreation Area

Forty-six organizations held outings at the Recreation Area during the Spring, Summer and Autumn of 1958. The total attendance at these affairs was close to 4,000, which represents the highest number in four years of operation.

The increasing popularity of this facility indicates clearly that the Arboretum is becoming better known, not only by the faculty and students at the University but also by members of an ever-widening community.

J. M. F., Jr.

# Associates' Corner

*We Associates enjoy our parties, treasure our plants, and are proud of our beautiful Arboretum, wandering through the grounds from time to time but, how many of us really know much of the actual functioning of the Arboretum? Dr. Fogg has kindly allowed me space in his Bulletin (a sort of Associates' Corner as the publishers term it) to tell of some of the contributions the Arboretum makes to the Community.*

## Our Contribution to Bowman's Hill Wildflower Preserve

Bowman's Hill Wildflower Preserve is in Washington's Crossing Park, and occupies a tract of 100 acres along Pidcock Creek. The Preserve started in 1933 as a living memorial to Washington and his valiant Army who camped here before the Battle of Trenton in December 1776. The ultimate horticultural objective is to establish a representative collection of the native flora of Pennsylvania, daily growing more valuable in this era of Suburban Sprawl. There are now fifteen Trails, short and easy to traverse, with the plants well marked. At the entrance to each Trail is a box containing identification lists of the plants on that particular Trail.

Material has come from all parts of Pennsylvania, mostly through seeds and cuttings which had to be propagated. Through the interest of our Mr. Joseph W. Adams the Morris Arboretum has helped to perform this function and there are now hundreds of plants thriving in this enchanted woodland with a Morris Arboretum heritage, including that unique shrub, the Box Huckleberry (*Gaylussacia brachycera*), the oldest living plant in North America, antedating the California Redwoods and the ancient Cypress in Mexico. The seeds are mostly infertile, but Mr. Adams was able to propagate cuttings from a stand estimated in 1920 to be 13,000 years old.

Marion W. Rivinus


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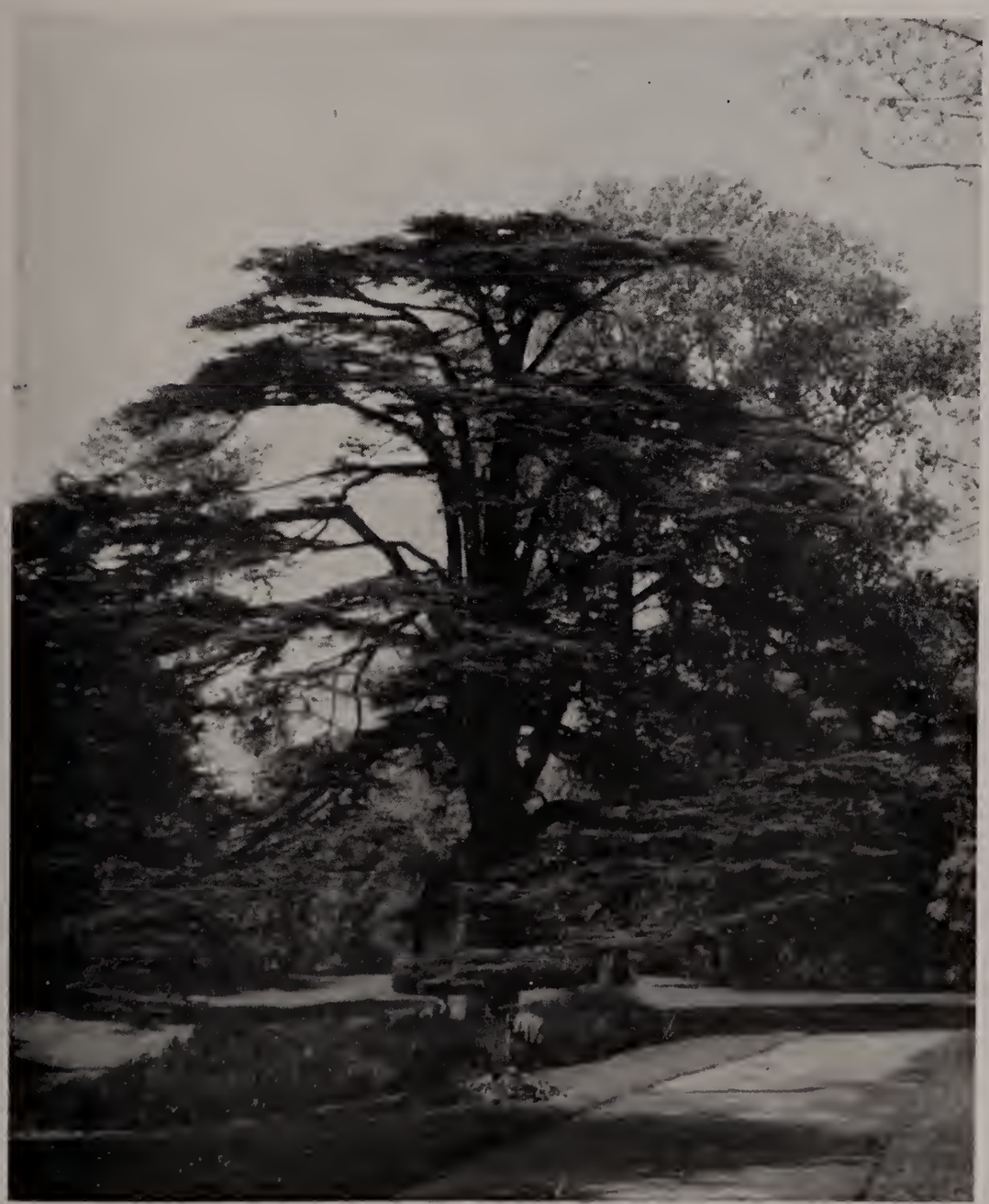
The Arboretum is happy to welcome the following new Associates who have been enrolled since January, 1958:

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# Morris Arboretum Bulletin

DECEMBER, 1958

VOL. 9 NUMBER 4



*Cedrus libani at Kew*

GRAY HERBARIUM
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The ASSOCIATES of
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# Arboretum Activities

## The Staff

On August 24 the Director attended the Annual Meeting of the American Association of Botanical Gardens and Arboretums which took place in Asheville, N. C. In September he flew to Paris to participate in a two-day session of the International Council of Scientific Unions Abstracting Board. This trip also provided an opportunity to visit the International Exposition at Brussels.

Dr. Hui Lin Li, Taxonomist, is actively pursuing his studies on the Trees and Shrubs of Formosa, a project which is supported by a grant from the National Science Foundation. In connection with this work Dr. Li has recently visited the Gray Herbarium of Harvard University, the Hebarium of the New York Botanical Garden and the U. S. National Museum in Washington. On Thursday, October 9, Dr. Li addressed the Pennsylvania Garden Symposium on "The Influence of Oriental Plants on Early Pennsylvania Gardens." Dr. Li's paper will appear in a future issue of this Bulletin.

Dr. Patricia Allison, Pathologist, represented the Arboretum at the annual meetings of the American Institute of Biological Sciences which were held in Bloomington, Indiana, from August 24 to 28. This was also the occasion of the Jubilee Meeting of the American Phytopathological Society.

*(Continued on Page 65)*

# Three Botanical Gardens of Britain

Hui-Lin Li

In the Fall of 1957, while on a study trip to the British Isles, I attempted, in the limited time at my disposal, to visit several leading botanical gardens. My British colleagues assured me that the three largest and best ones are, in this order: The Royal Botanic Gardens at Kew and at Edinburgh and the University Botanic Garden at Cambridge. After seeing these three and a few other gardens I fully agree with this evaluation and heartily recommend that all botanically-minded visitors to these islands make an effort to visit these institutions. No attempt will be made here to give an account of their history and present status, but only to discuss certain of their noteworthy features.

These three institutions are all botanical gardens in the traditional sense. In such gardens, in addition to outdoor plantings, extensive greenhouses are maintained for tropical or tender plants, museums of economic or ethnobotany are also maintained and there is usually a herbarium where basic research is carried on in taxonomy and related fields. In the outdoor plantings, species are arranged in various ways to show taxonomic, geographic or habitat groupings and the arboretum, while usually taking up the major portion of the ground surface, is only one kind of collection in addition to the inevitable rock garden. Botanical gardens seem to furnish an index to the cultural standards of a European city, for almost all leading ones, as well as many smaller ones, with a major university, have a botanical but not necessarily a zoological garden.



Fig. 34. Kew Gardens—View of Temperate House and Australian House (left).



Fig. 35. Kew Gardens—Interior of Temperate House.

We visited these gardens in the fall when few trees and shrubs were in bloom. Although a few kodachromes were taken, the more desirable views were not successfully recorded on account of the constantly overcast or rainy sky. In order to do justice to these beautiful gardens, the illustrations here presented were obtained from their official files; the generosity of the Directors of these gardens in making available these photographs with permission to publish them here in this Bulletin is here acknowledged with gratitude.

### Kew Gardens

The famed Kew Gardens, known to everybody interested in botany, needs little introduction. It is not only the best known botanical garden of the world, but its extensive herbarium and taxonomic library, the largest of their kind, render it the mecca of all plant taxonomists.



Fig. 36. Kew Gardens—Palm House.

The official name is the Royal Botanic Gardens, Kew. The Gardens date back to 1759 when Princess Augusta started a botanical garden of about nine acres in her private domain at Kew House. The House as well as most of the original trees have long since disappeared, but among the few surviving is a large Maidenhair tree, *Gingko biloba*. This ancient species from Asia is a "must" for every botanical garden and I was most interested to observe here the incipient stage of development of a branch hanging from the lower limb close to the trunk. This is a peculiar feature of Ginkgo, called *chi-chi* or *"nipple"* by the Japanese, a phenomenon occurring only on trees of great age. Eventually these branches will touch the ground and develop roots.

The extensive area of Kew covers over 300 acres. I was greatly impressed by the efforts which are made to preserve the place for botanical usage. The whole area is walled, and there is a small nominal charge for admittance. There are over forty guards on duty. Large billboards inside the entrances clearly inform visitors that games, picnics, bicycling and other such activities are prohibited; there are even signs on trees saying that nesting of birds is not allowed! No motor vehicles are used, even by the working crews, on the many wide well-paved roads. The guide book emphatically states that the gardens primarily serve scientific purposes and their use as a place of recreation, as thought of by most of those who come, is only incidental. Great care is certainly taken to maintain the place as a scientific establishment.

In the outdoor collection, most notable are the numerous beautiful specimen trees of great age and size seldom observed in the younger American botanical gardens and arboretums. Besides the huge Ginkgo, there are magnificent specimens of Atlas Cedar, Cedar of Lebanon, Stone Pine (*Pinus Pinea*), Swamp Cypress, Black Locust, *Sophora japonica*, Oaks, Ashes, Elms, Hollies, and numerous others. Walking under and among these wonderful old trees makes one realize why safeguarding the collections is of the utmost importance.

Not only are the grounds extensive, but there are so many special collections or areas worth visiting that it would take several days of intensive viewing to cover the outdoor living collections alone. There is the Rhododendron Dell, containing many rare species from the Himalayas and elsewhere. The Bamboo Garden is not only very pretty to behold but was of especial nostalgic import to me. The Herbaceous Garden is a long series of beds with all kinds of herbaceous flowers, sedges and grasses. The Wild Garden is a meadow with wild flowers. There are gardens for special habitats such as the Chalk Garden for plants preferring limey soil, the Rock Garden for alpine plants and the Aquatic Garden for water plants.

The numerous glass houses are another distinguished feature of the garden; I suppose nowhere else in the world can one see so many kinds of living plants growing together under glass. There are large conservatories for general collections, a temperate house for warm temperate plants, and economic houses for important economic plants of tropical or subtropical origin. There are special houses for palms, aroids, ferns, succulents, orchids, alpines and waterlilies. To me the most interesting is the Australian House because of its collection of unusual plants from that distant continent. (Figs. 34, 35 & 36).

Days can also be spent in the four museums which house many interesting displays of plant specimens and products of botanical, economical or ethnobotanical significance. (Fig. 37). For the less botanically-inclined there are a number of old buildings of historical interest such as the Dutch House or Kew Palace and various others.



Fig. 37. Kew Gardens—Museum No. 1.



Fig. 38. Kew Gardens—Chinese Pagoda.

Among these are also two Oriental structures. The Chokushi Mon is a replica of a famous Japanese Gate, a beautiful structure with exquisite carving. Less to be commended, although it is perhaps the most notable and famed building of Kew, is the Pagoda. It was built in 1761-62, when Chinese gardening was at the height of its popularity in Europe. Although the general outline is Chinese, the details such as texture of wall, design of windows, shapes of roofs, etc., are too distinctly occidental in appearance. (Fig. 38).

Kew is indeed a wonderful place. There one can spend a whole day with the family, enjoy the beauty of nature and absorb botanical knowledge consciously or unconsciously. Aside from being an important center of botanical research, the value of Kew as a place for educating the general public is enormous. The high cultural level of Britain can be seen in that, although public parks abound, there are always long lines of people, especially on Saturdays and Sundays, waiting to gain entrance to Kew by paying for admittance.

## Edinburgh Garden

At Edinburgh there is also a Royal Botanic Garden, much smaller in scope than Kew but quite similar in set-up. The garden was first founded in 1667. There was a succession of moves until it reached the present beautiful hilly site of over 50 acres to the north of the city. At the center of the garden high upon the hillside, it commands a magnificent view of the capital.

Edinburgh also has a famed herbarium, well known especialy for the collections of Forrest and others from western China. The researches conducted there on alpine Chinese-Himalayan plants, especially on *Primula* and *Rhododendron*, are among the most distinguished. These and other alpine plants are also most prominently represented in their outdoor collections. (Fig. 39). The vast collection of temperate Asiatic plants is the specialty of Edinburgh and was of particular interest to me.

There are many distinct features of Edinburgh. The Rock Garden is of course most famous. This large garden is noticed by the visitor as soon as he enters the gate. The wealth of alpine plants planted here is incomparable. (Figs. 40 & 41). According to the present director of the garden, Dr. Harold Fletcher, this vast pile of rock work, which took many years to build, is now considered rather an ugly structure. However, when the numerous alpine plants are in bloom, they nearly cover up the rock work and the whole thing is beautiful to see.

I have hitherto refrained from commenting on the rock garden of Kew. Although I have heard favorable comments on the one at Edinburgh which is more extensive, I have not heard similar comments as regards the one at Kew from those who have visited both. In general the rock work



Fig. 39. Edinburgh Garden—The azaleas in June.



Fig. 40. Edinburgh Garden—A general view of the Rock Garden.

of most rock gardens in Britain, to my eye, lacks imagination. The rocks are nearly all laid flat, piled up in more or less regular rows or terraces. True, there is a fundamental difference in the rock gardens of the East and the West. In the West the rock garden is only something to provide a suitable abode and background for the plants. But even primarily aimed for growing plants, a rock garden can be constructed in a more artistic and attractive manner. It should be possible, I think, to strike a balance between the East and West where rock gardens are concerned.

The Woodland Garden is a most pleasant sight, and reflects great skill in gardening and landscaping. This is developed from old stands of conifers, which in general are not doing well in the sooty atmosphere of Edinburgh. By judicious thinning and skillful planning, the open spaces are now filled with rhododendrons, primroses, lilies, and others, presenting a delightful



Fig. 41. Edinburgh Garden—The northern aspect of the Rock Garden with the scree.

sight. The Heath Garden, specially constructed with peat for the growing of ericaceous plants, is another interesting and beautiful feature. (Fig. 42).

At Edinburgh neither greenhouses nor all other features can be compared in extent with Kew. But with its more interesting terrain and excellent layout, there is a distinct charm in this garden.

### Cambridge University Garden

The Botanic Garden of Cambridge University now occupies a site of about 20 acres. It had its origin in another site, smaller than this, started in the 1760's. The old garden was removed to the present location in 1846. The ground is level, but with a lake and a mound, built up from the material dug from the lake and made into a rock garden, the flatness of the



Fig. 42. Edinburgh Garden—The Peat Garden, with woodland in the background.

area is not too conspicuous. (Figs. 43, 44 & 45).

Since the war, and upon the receipt of a sizable bequest, the garden has been continuously carrying out new developments and improvements. This rebuilding process was very evident when we visited the garden. The rock garden was then completely being overhauled. The garden is also expanding in size by reacquiring the other 20 acres originally alloted to it a hundred years ago. Among the new features in development is a Winter Garden. This consists of regularly arranged beds surrounded by a hedge and planted with species that will be in flower or in fruit at Christmas time. (Fig. 46).

According to the authorities of the garden, the dry gravelly soil, the low rainfall, and the sunny summers and rainy winters all make the place especially suitable for certain types of plants, such as those from the Mediterranean, Western Asia and California, but not for many others



Fig. 43. Cambridge Botanic Garden—The lake, with *Prunus avium* 'flore pleno'.



Fig. 45. Cambridge Botanic Garden—The Rock Garden with Japanese Cherry.

such as rhododendrons and related genera, except in specially prepared beds.

Although the climate and soil are also considered not suitable for conifers in general, there are unusually fine specimens of *Pinus monophylla* (*P. cembroides* var. *monophylla*) and *Juniperus phoenicea*. Both Red Wood and Big Tree are grown there. Among the other notable large trees are European Hornbean (*Carpinus Betulus*), Alders, Cedar of Lebanon, Atlas Cedar, and an interesting great thicket of *Pterocarya fraxinifolia*, the Caucasian Wing-nut.

Among the other interesting features are a Water Garden by the edge of the lake and beds of herbaceous or small woody plants arranged systematically. The greenhouses include a temperate house, a palm house, a fern house, an orchid house, a succulent house, etc. These houses, forming a range, have in between them bays which are exposed to the southern sun. These bays, protected from the cold winds, offer ideal locations for many subtropical or warm temperate plants ordinarily tender in that part of England. It is interesting to see growing here in the open New Zealand Veronicas, Crinums and other plants of the Southern Hemisphere and the tropics.

To a botanist in many parts of England it is striking to observe many plants that are not hardy in the Philadelphia area but can be grown outdoors here. At Cambridge, there are large clumps of *Ephedra*, large specimens of *Garrya*, a California plant, and the Palm *Trachycarpus excelsa*, all interesting and unusual. The last named is the hardiest of all palms and the only one which will survive in ordinary parts of England. It is of special interest to us because it is also planted in our native town Soochow in eastern China although it is indigenous further south. It will be interesting to find out whether this palm can also survive the winter



Fig. 44. Cambridge Botanic Garden—Limestone Rock Garden, with Metasequoia in the foreground.



Fig. 46. Cambridge Botanic Garden—The recently constructed Winter Garden, *Prunus Davidiana* 'alba' in flower, *Crocus* species underneath

of Philadelphia if certain hardier strain can be selected and grown in protected spots as is done with *Camellia japonica,* Fig, and a few other plants.

It is evident to the visitor that the Cambridge garden is now undergoing active rebuilding. With the aid of new resources, many new developments are being planned. Aside from the Winter Garden, a new herbaceous border, an ecological area, a herb garden, a new laboratory, greenhouses and other features are being planned or developed. In a few years, the Cambridge garden will surely become one of the leading botanical gardens of the world.

# To Eat or Not to Eat

Patricia Allison

The beams and girders of the oaks stand bare in autumn repose. Richly dark against the gray tracery of branches and ever grayer sky are the conifers, thickly needled. In the azalea meadow, the floor of the Arboretum is clean, but elsewhere the rustling wind sweepings are piled deep. Although the year is nearly over, each day still supplies a new change, a new contrast. The transience of each succeeding aspect is a large part of the appeal of the Arboretum, for it must be visited and revisited as the seasons' changes in bud, flower, and fruit arrive, pause, and disappear.

Among the most transient of all the Arboretum flora are the fruiting bodies of the fleshy fungi, yet there are individuals scattered here and there almost throughout the year. During spring, summer and fall, when warm days follow rains, the "fungus bloom" may be spectacular. The very azalea meadow that now is bare was dotted for several weeks in late summer with large puffballs, at first snow white, then tan and brown.

In the woodland along the Wissahickon there was a continuous display of gill fungi, bracket fungi, jelly fungi, and even the tiny fruiting bodies of the slime molds. Some of these were inconspicuous because of size or because they blended subtly with the forest floor or pushed up in dark places beside logs and under leaves. Others were exposed in dramatic contrast to their substrates: the alabaster shelf fungus growing from the hemlock bark, the cinnabar bracket on gray beech, the coral mound of the slime mold fruiting body on yellow, disintegrating log. Many of these will be pictured and discussed in the future, but first some other consequences of the periodic abundance of fleshy fungi must be considered.

When the "fungus blooms" come, so also come the inquiries about "mushrooms versus toadstools." This also is the season for newspaper reports of deaths from fungus poisoning. The details of the uncertainties that underlie the inquiries vary, but they usually represent suspicion of one of the commonly held opinions about fungi. Such suspicion should have been shared by the victims chronicled in the newspaper.

Orbiting satellites notwithstanding in this Scientific Age, popular ideas about fleshy fungi have remained at about the same level for centuries. Too many believe that poisonous fungi are in a group by themselves and should be referred to as toadstools; that nonpoisonous fungi are as different as cats from dogs and are called "mushrooms" (when asked what the difference between them is, the usual reply is that nonpoisonous ones are mushrooms and poisonous ones are toadstools! Who ever goes to market for toadstools anyway?)

These individuals have the matter settled and are never tempted to gather the delicacies in any forest save the supermarket jungle. They stay alive, to be sure.

Too many others, however, feel really confident that a single physical characteristic distinguishes all poisonous mushrooms from all safe ones. What this characteristic may be has been carefully hidden from all but a few persons. And so we hear, "My grandmother from the old country says thus and so, and *she* lived to be 99!" There is a different method for every old country and just about every grandmother.

There is only one *single* sure method of distinguishing the mushroom poisonous to man from one not poisonous. This is the direct method. Eat it. If you don't have to call the doctor or undertaker, it's all right. This method is definitely not on the recommended list, but the methods suggested by various folk lores can be just as lethal.

Fortunately, there are relatively few poisonous species, and chance alone has lent seeming validity to some of the old wives' tales.

There is no single distinguishing characteristic! Consequently, if one decides to go to the woods and field instead of to market for his mushrooms, common sense dictates that he be properly prepared for the expedition. A basket and an appetite are not sufficient. By far the most important equipment is a thorough knowledge of the characteristics of the common species and an equally thorough knowledge of a few of the most distinctive edible species. All doubtful collections, unless checked by an expert, should be discarded as food. This does not mean that an individual should always limit himself to a few species. The mushroom hunter may always improve his "equipment", adding more species to his desirable list as he becomes more familiar with the morphological characteristics of fungi. Never should he resort to the use of a "universal rule", no matter how tempting it should be. Below are some of the commonest misconceptions. It is followed by a list of more useful rules for the beginner, as compiled by Atkinson.

"Old Wives' Rules" (from McIlvaine)

1. There are two types of fungi: Mushrooms, which are edible, and Toadstools, which are poisonous.
2. Snails and slugs infest poisonous species only.
3. Mice, squirrels, rabbits, etc. eat only the nonpoisonous species.
4. Any mushroom growing in the dark is poisonous.
5. All nonpoisonous species have all gills equal in length.
6. All poisonous species have thin tops.
7. All poisonous species turn yellow when sprinkled with salt.
8. All poisonous species will blacken a silver spoon.
9. Any fungus which changes color when cut or broken is poisonous.
10. Any fungus which exudes milky juice is poisonous.
11. Any fungus with a bad odor, bad taste when raw (or general suspicious appearance!) is poisonous.

Helpful Aids to the Beginner

1. Reject those whish have begun to decay or are infested with insect larvae.
2. Reject all those in the button stage. Sure distinguishing characteristics are not present then.
3. Reject all with a volva, (a basal cup-like structure) or which have a scaley or closely fitting layer at the base of the stem, and rather loose warts on the pileus, (cap) especially if the gills are white.
4. Reject all with a milky juice unless the juice is reddish.
5. Reject very brittle fungi with gills nearly all of equal length, where the flesh of the cap is thin, especially those with bright caps.
6. Reject all Boleti (fleshy fungi with tubes instead of gills) in which the flesh changes color where bruised or cut, or those in which the tubes have reddish mouth, also those whose taste is bitter.
7. Reject those which have a cobwebby veil or ring when young, and those with slimy caps and clay-colored spores.

The rules above will cut out a few very desirable species and many doubtful ones. This is vastly superior to leaving in one or two deadly species. It should be added that the collector should make notes of the growth habit and habitat. He should also be sure that no part of the fruiting body is left in the soil.

Common Poisonous Species

Below is a list of the most common poisonous species. The opinion seems to be shared by many mycologists that some species may have undeserved bad reputations. It is difficult to say with certainty what has caused an illness when the offender cannot be recovered in an identifiable state. Furthermore, variations in susceptibility to toxins of consumers or genetic variations among individuals of a given fungus species contribute to considerable confusion. The grim history of certain members of the genus Amanita, however, is much clearer. Since it has been estimated that ninety per cent of all deaths due to mushroom poisoning are caused by three members of this genus (1, 2 and 3 below), its characteristics are given. It is suggested that the beginner avoid all members of the genus even though a few are not poisonous. He should become familiar with the characteristics of the other genera containing poisonous species, and collect them only for practice in identification until he is confident of his knowledge of species characteristics.

1. *Amanita phalloides*
2. *A virosa*
3. *A. verna*
4. *A. caesarea (?)*
5. *A. muscaria*
6. *A. pantherina*
7. *A. rubescens (?)*
8. *Boletus satanus*
9. *B. mineato-olivaceus*
10. *Clitocybe illudens*
11. *C. morbifera*
12. *C. nebulosus*
13. *Entoloma lividum (Rhodophyllus lividus)*
14. *E. sinuatum (Rhodophyllus sinuatus)*
15. *Hebeloma spp.*
16. *Helvella esculenta*
17. *Hygrophorus conicus (?)*
18. *Inocybe infelix*
19. *I. infida*
20. *Lactarius torminosus*

21. *Lepiota Morgani*
22. *Panaeolus papilionaceus*
23. *P. retirugis*
24. *P. campanulatus*
25. *Pholiota autumnalis (Galerina autumnalis)*
26. *Russula emetica*

Members of the genus *Amanita* are recognized by the presence of both annulus (ring around the stem) and volva. Considerable skill is required to identify some species with inconspicuous volvas. The cap separates easily from the stem. All grow on the ground. The gills are free from the stem; spores are white.

The poisonous species may be divided into two general groups with respect to the action of their poisons. If members of the first group are eaten in quantiy, it is suggested that the individual write his will in addition to calling the doctor. If members of the second group are eaten, nature will probably take its course and the victim will recover after considerable discomfort.

To the first group belong *A. muscaria, A. phalloides, A. verna, A. virosa, A. pantherina, Pholiota autumnalis, Hygrophorus conicus. Inocybe infelix, I. infida,* and *Clitocybe illudens.* Because symptoms generally appear several hours after eating and after sufficient quantities of poison have been absorbed to affect the nervous system, the use of emetics and stomach pumps is of no avail. In the case of *A. muscaria,* at least two separate compounds are responsible for the symptoms. One, muscarine, causes the first signs of poisoning and depresses the heart. If atropine is administered early enough, these symptoms may be alleviated, but the drug has no effect on the other, more severe secondary symptoms involving the nervous system. Recovery depends largely on the amount of poisonous fungus consumed.

To the second group belong *Russula emetica, Lactarius torminosus, Lepiota Morgani, Entoloma lividum, Boletus satanus, B. mineato-olivaceus* and some Amanitas which cause nausea, vomiting, and diarrhea; *Helvella esculenta,* other Helvella species, and *A. rubescens,* which may cause vomiting of blood, convulsions, depression, and mild jaundice; *Panaeolus papilionaceus* and *P. campanulatus,* which cause symptoms similar to intoxication.

Further information about the symptomology and toxicology of the first group, based on work with experimental animals, may be found in McIlvaine. Wolf discusses the nature of the toxic substances, and Gussow gives case histories of poisonings. Accurate descriptions of the poisonous species are found in these books.

### Choice Edible Fungi

1. *Psalliota (Agaricus) campestris* — common mushroom A Mc
2. *Coprinus comatus* — shaggy mane (when young) A Mc
3. *C. atramentarius* (when young) — common ink cap A
4. *C. micaceus* — (when young) shiny ink cap A
5. *Pleurotus ostreatus* — oyster mushroom A Mc
6. *Lepiota procera* — parasol mushroom A
7. *Armillaria mellea* — honey agaric
8. *Collibia velutipes* — violet stemmed mushroom
9. *Morchella esculenta* — morel A Mc
10. *Fistulina hepatica* — beefsteak mushroom Mc
11. *Cantharellus cibarius* — chanterelle Mc
12. *Hypholoma* spp. A Mc
13. *Lactarius deliciosus* A Mc
14. *Marasmius oreades* Mc
15. *Clitocybe multiceps* Mc
16. *Boletus edulis* A Mc
17. *Hydnum* spp. A
18. *Tricholoma personatum* Mc
19. All *Clavaria* spp. A Mc
20. All puffballs which are pure white in section A Mc

The species marked with A above are included in special recipes by Mrs. Sarah Tyson Rorer in Atkinson's book. There are special recipes in McIlvaine for those marked Mc. Gussow also includes recipes as well as a section on the culturing of fungi.

Fungi are prized more for their flavor than for their food value. Like most vegetables, they are mostly water and low in calorific value. It does appear that they rank along with some vegetables in nutritive value. A few species, as *Cantharellus cibarius,* are known to be sources of vitamin D. Others are rich in other vitamins. More work needs to be done on the food value of these plants.

This general discussion would not be complete without a brief consideration of the fungi which are poisonous to organisms other than man, and to man in different ways than mentioned above.

Of extreme importance are those which are parasitic on crop plants. Not all of the damage by fungi may be considered to be due to mechanical injury or physical disorganization of the protoplasm. Toxic substances are produced in many cases. One plant parasitic fungus, *Claviceps purpurea,* causes ergot of grains, destroying not only the grain itself, but causing severe diseases of livestock and man if eaten.

Some fleshy fungi are parasitic on others, as members of the genus *Nyctalis,* which grow on other agarics, or *Boletus parasiticus* which parasitizes certain puff balls.

Of great importance to man are those fungi which produce substances which are toxic to bacteria, as species of *Penicillium* and *Aspergillus.*

Mention should also be made of the fungi which cause diseases of man and animals. *Coccidioides immitis* causes a fatal malady of cattle, sheep and dogs. Many fungi cause serious respiratory and skin diseases of man. Two of the common, less serious skin diseases in the United States which are caused by fungi are Athlete's Foot and Ringworm.

### Recommended Reading


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# An Early-flowering Shrub Garden


John M. Fogg, Jr.,


The walled terrace and adjacent lawns directly behind the Gates Building have recently been cleared of their pre-existing plantings and are being transformed into a garden of shrubs which flower in late winter or very early spring. Owing to its southern exposure and protection from north winds, this location provides an ideal site for exhibiting a small number of carefully selected shrubs which may be counted upon to provide a show of color from February (or even January) to late March or early April.

Among the species which have already been established in this collection are the following:

Cornelian Cherry (*Cornus mas*). Our records, maintained over a period of fifteen years, show that this species may develop its myriads of small yellow flowers as early as February 10 and that its average date of bloom is March 12.

Japanese Cornelian Cherry (*Cornus officinalis*). This attractive Oriental cornel usually blooms at about the same time as the foregoing species; it has even been recorded as having preceded it by several days.

Winter Honeysuckle (*Lonicera fragrantissima*). This fragrant-flowered, half-evergreen Chinese shrub has been recorded as flowering here on January 17. Sporadic flowers frequently appear during warm spells in February and the plant may be relied upon to be in full bloom during the first week in March.

Standish Honeysuckle (*Lonicera Standishii*). Similar to the preceding species, but with hairy instead of smooth foliage. Blooms at about the same time.

Wintersweet (*Chimonanthus* (*Meratia*) *praecox*). Wintersweet has been reported in flower during December, January and February. It is a species which responds readily to a few warm, sunny days throughout winter, although frequently its blooms are killed by a sudden drop in temperature.

Winter Jasmine (*Jasminum nudiflorum*). This is another species which may be expected to put forth a few tentative flowers any time between mid-December and the end of February. It is usually in full bloom by March 1 and may continue to flower until the middle of the month.

Japanese Andromeda (*Pieris japonica*). An evergreen shrub with pure white, bell-shaped flowers in drooping racemes. Its earliest recorded date of bloom here is March 3, its latest April 15. In average years the plant will be seen in full bloom from the middle to the end of March.

Japanese Witch-hazel (*Hamamelis japonica*). Although our native eastern witch-hazel (*H. virginiana*) blooms in late autumn, the oriental species put forth their flowers in late winter or very early spring. *H. japonica* may be counted on to open its bright yellow corollas in early March and to furnish a display of color until the first of April.

Winter-hazel (*Corylopsis spicata*). The increasing popularity of the Winter-hazels derives from their habit of producing drooping racemes of bright yellow flowers in late March or early April. This species is among the earliest.

Spice Bush (*Lindera Benzoin*). A native of

our eastern deciduous woodlands, this shrub usually comes into bloom the third week in March, its numerous small yellow flowers persisting until mid-April.

Japanese Quince (*Chaenomeles superba*). The blood-red flowers of this quince (supposedly a hybrid between *C. japonica* and *C. lagenaria*) render it one of the most spectacular of all early-flowering shrubs.

Almond (*Prunus Amygdalus*). This old-fashioned favorite is one of the tardier early-spring bloomers seldom putting forth its best effort until the end of March or early April.

Among other species of early-flowering shrubs which will later be moved into this planting are:

Winter-hazels (*Corylopsis sinensis* and *C. Veitchiana*).

Witch Hazels (*Hamamelis vernalis* and *H. mollis*).

Purpus Honeysuckle (*Lonicera Purpusii*).

Pussy-willows (*Salix discolor, S. caprea* and *S. gracistyla*).

Persian Ironwood (*Parrotia persica*).

Holly-grapes (*Mahonia Aquifolium* and *M. Bealii*).

Early Rhododendrons (*Rhododendron mucronulatum* and *R. dauricum*).

Fragrant Viburnum (*Viburnum fragrans*).

In close proximity to the species already enumerated will be found such shrubs as the Bridal Wreaths (*Spiraea spp.*) and Forsythias, whose flowering announces the close of winter and the advent of Spring.

It is hoped that visitors to the Arboretum as the days begin to lengthen will enjoy this concentration of hardy pioneers of a new flowering season.

# Book Review

Garden in Your House, by Ernesta Drinker Ballard, Foreword by John M. Fogg, Jr. Harper & Brothers, New York, 1958.

This new book, written by Mrs. Ballard, is a reference work on indoor plants designed for the general public. It is divided into four parts. Part I "The Culture of Indoor Plants" deals with caring, potting, watering, fertilization, pest control and propagation, and explains in a non-technical language the basic reasons behind each step by reference to elementary botany. Part II "Some Indoor Gardens," describes different types of window, porch, alcove, cellar, office and store gardens that can be set up in endless variations. Part III "Selection of Plants," the major section of the book, deals with some 500 species and varieties of plans suitable for indoor growing. A great wealth of information on the appearance, uses, and methods of growing of all these plants is to be found. Part IV "Finding Lists" contains lists of plants for various exposures and temperatures, potting mixtures and growing mediums, sources of supply for home plants, and suggested readings for indoor gardeners. There is also a good index.

Mrs. Ballard writes with authority, as she has grown nearly all the plants described therein. The warm personal style makes for smooth enjoyable reading. The book is profusely illustrated with more than 90 half-tone plates.

This volume, based on the author's own observation and experience, stands out refreshingly among the multitude of garden books published each year as one which is original, accurate and reliable. Every grower of indoor plants, professional or amateur, who wants to possess at least one book for reference, should have this one.

H. L. Li

# New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since September, 1958:

Mr. and Mrs. Baldwin Brown
Mrs. Louis Conseur
Mrs. Bernard Eskin
High Field Elementary School
Miss Barbara Jean Lyon
Mr. and Mrs. Robert L. McNeil, Jr.
Dr. and Mrs. H. F. Parry
Mr. and Mrs. Harold F. Pitcairn
Southampton Nurseries
Mrs. Stewart H. Steffey

# Arboretum Activities

*(Continued from Page 54)*

Miss Mary Milton, Propagator, attended the meetings of the Plant Propagators' Society in Columbus, Ohio, from December 3 to 6 and gave an illustrated lecture on "Noteworthy Woody Ornamentals."

Mr. Fred W. Schwoebel, Curator of the Langstroth Bee Garden, has recently returned from four months in Europe where he visited many important botanical gardens in the British Isles, Spain, Switzerland, Germany, Austria and Italy. Mr. Schwoebel made a special study of the cultivated Evodias from the point of view of the beekeeper and prepared a paper on the use of Evodias in the United States for presentation at the International Beekeepers' Congress in Rome in September.

## From our Guest Book

Among recent distinguished visitors to the Arboretum who have signed our Guest Book are the following:

Nixon Smiley, Director of the Fairchild Tropical Garden, Miami, Florida.

Walter H. Hodge, Director of Education, Longwood Gardens, Kennett Square, Penna.

Takao Nakamura, Professor of Biochemistry, University of Tokyo, Japan.

Joseph Ewan, Professor of Botany, Tulane University, New Orleans, La.

George Taylor, Director, Royal Botanic Gardens, Kew, England.

Peter Bjejoric, Institute for Plant Protection, Belgrad, Yugoslavia.

Asger F. Langlykke, Squibb Institute for Medical Research, New Brunswick, New Jersey.

Eric Buxton, Plant Pathologist, Rothamsted Experiment Station, Harpenden Herts, England.

Christian Baron, Department of Biochemistry, Institute of Science, Dijon, France.

## Grid Markers

Reference has been made before in these notes to the Grid Survey of the Arboretum which was carried out during the summer of 1957. The corners of the grids, each 200 feet on a side, were originally marked with wooden stakes. One of our important projects this autumn has been to replace these stakes with permanent cement markers, sunken into the earth so that the top of each is level with the ground. Each marker bears a symbol, such as A 12 or P 8, which identifies the grid of which it forms the northwest corner.

## Transplanting Program

Spring and autumn are, of course, the preferred seasons for transplanting trees and shrubs. Spring is actually a more favorable period for this operation, but since it is also a time when so many other tasks must be performed, we have adopted the practice of moving most of our plants out of the nurseries in the fall.

Most of our efforts this year have been devoted to adding to the representation of certain families and genera which have already been established on the 70-acre area known as Bloomfield, which lies to the north of Northwestern Avenue. Among the genera to which substantial additions have been made from nursery grown stock are *Chionanthus, Lonicera, Viburnum, Hydrangea* and *Berberis.*

Our largest collection of hollies occupies the slope just below the Gates Building. To this planting, which consists primarily of evergreen forms, there have now been added, in groups of three each, three deciduous species: *Ilex geniculata, I. serrata* and *I. verticillata.*

The area directly in front of the Gates Building has been replanted with new foundation material and the lawn behind the building is being converted into an early spring garden. The latter undertaking is described in some detail elsewhere in these pages.

## The Herbarium

One of the discouraging features in the maintenance of an herbarium, or collection of pressed and dried plants, is the steady accumulation of unmounted specimens acquired from a variety of sources. The Arboretum herbarium has been no exception to this rule and during the last few years many hundreds of specimens have been piling up in the storage bins. It is a pleasure to be able to report that this mass of unmounted material is now being reduced. Mrs. Joseph N. Du Barry, a volunteer worker, has mounted some 500 sheets in the last year or so and we are deeply grateful to her for her efforts. Mr. Zoltan Porga, a member of our staff, has for some months devoted all of his time to this task, with the result that over 2500 additional sheets have been mounted and incorporated into the herbarium. Included in this total are more than 1200 plants from Formosa, material from India and California, as well as many plants from our local area.

J. M. F., Jr.

# Associates' Corner

## The Arboretum and the Agricultural Research Service

One of the four Research Laboratories of the United States Department of Agriculture is situated right in our midst at 600 East Mermaid Lane, Wyndmoor, Pennsylvania. Utilization Research, as it is termed, became a recognized program of the U. S. Department of Agriculture in 1938 when, Congress provided for the construction of four new laboratories, one in each major farm-producing area. Our local one was established in 1940.

The work of these laboratories is to find new and wider outlets and markets for farm commodities, especially those in surplus, the utilization and disposal of agricultural wastes, and research on allergens.

In the fundamental studies and research of the Biochemical Section, devoted to honey plants and maple syrup products, the Morris Arboretum has been most helpful, both because of proximity to the raw materials and through the cooperation and botanical knowledge of members of our Staff. Sugar maple trees are not too plentiful in this part of the country, and the laboratories needed a lot of fresh sap. They were able to tap some 50 trees growing around the periphery of the Arboretum, which has vastly improved the gathering, processing and distribution of maple products.

Rutin, a plant drug, used in hemorrhagic and other diseases comes from buds of the Chinese Scholar Tree, *Sophora japonica* L. This used to be imported from China. The Arboretum has a splendid specimen which, since 1950 has been supplying far fresher material.

The twigs and leaves of the Chaste Tree, *Vitex Agnus-castus,* obtained by Dr. J. J. Willaman, in large quantities from the Arboretum, furnished an extract called flavonoid which was sent to the Stanford Medical School for tests against certain viruses.

Nectar from *Evodia Daniellii,* the famous Bee Bee Tree, was gathered from the Langstroth Bee Garden of the Arboretum. The report states that the best way to obtain this nectar is, to let the bees collect from the flowers and then squeeze the bees! I wonder who does the squeezing?

Alkaloids are known for their physiological activity, and have many medical uses such as in hypertension and malaria. Numerous plants of the Solanaceae or Nightshade Family contain alkaloids. Dr. T. D. Fontaine obtained two species of *Solanum* from our collections, one of which had a very high alkaloid content.

Red sour cherries are another fruit that is somewhat infrequent in these parts. Dr. R. T. Whittenberger needed fresh fruit direct from the tree. Again the Arboretum came to the rescue.

Just recently Dr. R. L. Pollack needed some fruits with sizable seeds and fleshy pulp. Dr. Fogg took him on a tour of the grounds and they found ten species which would meet the requirements including, of all things, the smelly Ginkgo by the front door of the old mansion.

One of the researches, which appeals to us gardeners, is the study of various plant-growth regulators (including weed killers).

Some uncultivated plants are used for the study of cortisone, used in the treatment of arthritis and related conditions.

As the Research Laboratory Library does not include works on botany the scientists at the Laboratory make frequent use of the Arboretum Library. In return for the Arboretum's cooperation, hybrid seed, produced by Drs. J. W. Wright and E. J. Schreiner of the U. S. Forest Service working at the Arboretum, were stored in a constant temperature refrigerator at the Laboratory and Dr. Willaman's compilation of alkaloid-bearing plants was placed at the disposal of Drs. Fogg and Li. Several members of the Research Staff are included in the roster of Arboretum Associates and Dr. J. J. Willaman, Director of the Biochemical Department, is on our Advisory Council.

Marion W. Rivinus

# Library Accessions

The following items have been added to the Arboretum Library during 1958:

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# Arboretum Activities

## The Staff

The Director has been invited by Dr. Alan T. Waterman, Director of the National Science Foundation, to serve on the newly formed Science Information Council. The primary function of this Council will be to study the means whereby the rapidly increasing volume of scientific literature throughout the world may be made more readily available to scientists.

Dr. H. L. Li, Taxonomist, departed on March 19th for a two and a half month's stay in the Far East in connection with his studies on the trees and shrubs of Formosa. He will visit the important botanical collections in Hong Kong and Formosa and will spend most of his time working in the large herbarium centers in Tokyo and Kyoto.

*(Continued on Page 14)*

# The Influence of Oriental Plants on Early Pennsylvania Gardens[1]

Hui-Lin Li

Botanical and horticultural contacts between North America and the Far East in colonial times were not direct but took place through Europe. The early American colonists, like all other emigrating people, were at first, for sentimental reasons and by personal preference, more interested in the plants of their original home than in the native plants of their new land. Seeds of vegetables and trees brought over from the Old World were planted out by the pioneer settlers within days after their arrival and as soon as land could be cleared.

## Introduction of Oriental Plants to Europe

Among these early introductions from Europe were plants of eastern Asiatic origin, for a number of plants from China were already in cultivation in Europe by the 17th century. A few plants, like the Peach, Day Lily, White Mulberry, Shrubby Althea, Persian Lilac, and Weeping Willow were carried from China to central and western Asia in fairly early times across the deserts of central Asia by the celebrated Silk Route. Then in the 16th century, the Portuguese brought Sweet Orange from China through early sea trade. The sea trade of the Dutch with eastern Asia in the 17th century brought first to Europe such ornamental plants as the well known Japanese or Indian Azaleas (*Rhododendron indicum*) and the Garden Chrysanthemums (*Chrysanthemum sinense*). The Dutch were especially successful in their commercial enterprise in Japan whence they also introduced into Europe such economic plants as the Camphor tree and the Tea plant. (Fig. 1)[2]

In the eighteenth century the contacts made by Europeans with China and Japan were much more numerous. In addition to the Portuguese and Dutch, Englishmen, French, Swedes and many others participated. Besides traders, Catholic missionaries were notably active. Many learned Jesuit fathers were interested in the plants and plant products of the East. During this century we note the work of such famous botanical explorers as James Cunningham of England, who collected in China in 1701, Peter Osbeck of Sweden, who collected in China in 1751, and Karl Peter Thunberg, also of Sweden, who collected in Japan, 1775-76. Magnus von Lagerstroem (1696-1759), a Swedish naturalist who had never been in Asia, was instrumental in introducing the Chinese Crape Myrtle (*Lagerstroemia indica*) into Europe. The species was named by Linnaeus in honor of his friend.

Among the Jesuit missionaries of this period, the most celebrated name is D'Incarville, a Frenchman, who spent nearly 17 years (1740-1757) in China and who first introduced from China to Europe, among other things, Tree of Heaven (*Ailanthus altissima*), Chinese Scholar Tree (*Sophora japonica*) (Fig. 2), Oriental Arborvitae (*Thuja orientalis*), Goldenrain-Tree (*Koelreuteria paniculata*), Jujube (*Zizyphus Jujuba*), as well as the Chinese Cabbage and Mustard. Joannis de Loureiro, a Portuguese missionary to China and Indo-China, 1735-1782, also collected and studied the floras of these countries. Thus in the 18th century, a large number of Chinese and Japanese plants were already established in European gardens, and these were introduced, along with plants of European origin, into the newly established colonies in America. Around the middle of the eighteenth century, besides those we have mentioned, some other Oriental plants then available were Holly-



Fig. 1. The Camphor Tree was an early introduction from China. This one grows in Alabama. (U. S. Forest Service photo).

[1]Based on a talk given at the Symposium on Pennsylvania Gardens, Strawberry Mansion, Philadelphia, on October 9, 1958.

[2]Cover illustration and figs. 1, 3, 4 and 9, courtesy of Mr. William R. Carpenter.



Fig. 2. The Chinese Scholar Tree was introduced into the Western garden by D'Incarville in the middle 18th century.

hock (*Althaea rosea*), Bleeding Heart (*Dicentra spectabilis*), Chinese Pink (*Dianthus chinensis*), St. John's Wort (*Hypericum patulum*), Camellia (*Camellia japonica*), Rose-of-China or Chinese Hibiscus (*Hibiscus Rosa-sinensis*), Rose-of-Sharon or Shrubby Althea (*Hibiscus syriacus*), Touch-me-not (*Impatiens balsamina*), Chinese Honey Locust (*Gleditsia sinensis*), China Rose (*Rosa chinensis*), Bank's Rose (*Rosa Banksiae*), Cherokee Rose (*Rosa laevigata*), Chinese Matrimony Vine (*Lycium chinense*), Cockscomb (*Celosia argentea*), Wikstroemia (*Wikstroemia indica*), and Chinese Juniper (*Juniperus chinensis*).

Eastern Asiatic plants cultivated in European gardens toward the end of the 18th century were even more numerous, including various garden species of Magnolia, Rose, Lilac, Privet, Peony, Honeysuckle, Cherry, Hydrangea, and many others. Especially to be mentiond is Ginkgo or the Maidenhair Tree, the oldest of living tree species, which was introduced into Europe toward the middle of the 18th century, and a most sought after tree for every botanical garden.

### Early Trends of American Gardening

We can thus see that a large number of plants of Asiatic origin were available to the early gardeners in the New World. In the 17th and 18th centuries, Chrysanthemum, Hollyhock, Cockscomb, Peony and Day Lily decorated the front yard garden and flower borders of old New England towns. Camellia, Crape Myrtle, Honeysuckle, Bank's Rose and Azalea were popular plants in the gardens of Virginia and other southern states. But perhaps even more profound were effects wrought by eastern Asiatic plants upon the horticulture and gardening of the Middle Atlantic States, especially in the Philadelphia area.

Here, as we all know, was located the first permanent botanical garden. Here was the place that set up the trend of American landscaping for years to come. As I see it, most of the early gardens of Pennsylvania were not gardens of flowers, but gardens of trees and shrubs. The botanical gardens of America are mostly aboretums and not the usual type of botanical gardens of the Old World where hot houses and flower beds are the dominant features. For landscaping in American gardens the popularity of informal gardens over geometric types was very early noted.

The molding of these trends was undoubtedly due in part to the exceedingly rich sylvan wealth available to the early settlers. True it is that in Europe the formal type of garden with geometrical design was already declining in popularity and the natural or landscape style was gaining. (This trend, developed first in England, was, as generally noted, mainly due to the influence of Chinese gardens.) But the presence of the nu-



Fig. 3. This Ginkgo tree in Bartram's Garden is supposed to be the first in American. Photo taken in 1956 by W. R. Carpenter.



Fig. 4. This Ginkgo tree in Tyler Arboretum was planted in 1849. Photo by W. R. Carpenter.

merous kinds of trees and shrubs, and the beautiful natural scenery provided by these plants, may have exerted an appreciable influence in the major trends of gardening in this new land, The available kinds of exotic trees and shrubs from Asia, notable either for their unusual interest or beauty, no doubt enhanced the movement of arboretum building and naturalistic gardening, The remarkable success of eastern Asiatic plants in eastern North America, greater than in Europe, was due to the geographical and geological relationships of the two distant floras, a fact which was made known at a later date and which has since affected American gardening even more profoundly than before.

Turning more specifically to early Pennsylvania gardens, though few records of lists of plants in these early ones are extant, we still have some general knowledge about the gardens of colonial Pennsylvania. We know that the early Germantown settlers, at the beginning of the 18th century, had a passion for flowers, and in their family gardens were found such Oriental plants as Hollyhock and Chrysanthemum. Later there were larger gardens of beauty, and plants like Snowball, Pinks and Lilies were among the favorite flowers used. Soon every house was shaded with trees, with the Asiatic Weeping Willow as popular as the European Lombardy Poplar. Fruit trees were of course planted early, and among these were the Peach and Apricot of Chinese origin. People were in general interested in the cultivation and the introduction of rare trees.

### Bartram's Garden and the Woodlands

Thus in Bartram's Garden (started in 1728) although it was primarily for native species, the Ginkgo figured most prominently. The unique Ginkgo tree from China was the favorite importation of many early American gardens. The Bartram tree is supposed to be the first one introduced into America. Another early introduction, believed by some to be even earlier than Bartram's, is in the nearby Woodlands, a garden started by Andrew Hamilton in 1735. This tree, still extant, has been called one of the arboreal treasurers of Philadelphia and is visited by tree lovers from all parts of the world.

For a while The Woodlands was cared for by the famous botanist, Frederick Pursh. Toward the latter part of the 18th century The Woodlands, which then belonged to William Hamilton, became the finest garden of exotic plants in America. Asiatic plants then in cultivation, beside Ginkgo, included Crab, Zelkova, St. John's Wort, Honeysuckle, Peonies, Hollyhock, Lilies, Oleander, and Crape Myrtle. It had the first Ailanthus or Tree of Heaven planted in American (in 1784) . There were extensive greenhouses and orangeries. The influence of The Woodlands on American horticulture and landscaping is immense. It brought in very many interesting exotics and set the trend for foreign plant introduction and for the establishment of arboretums. It also greatly influenced Thomas Jefferson, the father of American landscaping, who obtained from The Woodlands many plants for Monticello.

### Ginkgo and Ailanthus

Ginkgo, as mentioned before, was one of the most favorite trees of early American gardens. Many fine old specimens can still be seen around the Philadelphia area. The first one on record to bear fruit was that one in John Wister's garden in Germantown, where the Mansion was built in 1744. This tree was supposed to have been received from Japan as a seedling, a gift from the Japanese Emperor to John Wister and is believed by some to be the earliest introduction to this country. A study of the history of old



Fig. 5. The Japanese Snowball was first introduced into American gardens in the early 19th century.

Ginkgo trees in Philadelphia is a fascinating subject, as there are many claims as to which was planted first. Another important center of plant introduction was the Botanic Garden of Humphrey Marshall, started in 1773, where many exotics were planted along with native plants. (Figs. 3 & 4).

A major event in American horticulture took place in 1784 when David Landreth, an Englishman, established a seed house in Philadelphia, the first important concern of its kind. It developed into the largest seed house in the latter part of the century and for some time specialized in roses, camellias, rhododendrons, azaleas and magnolias, — plants mostly of Asiatic origin. In the greenhouses great numbers of oranges, lemons and shaddocks were grown.

Lest one think that the influence of Oriental plants on early American gardens is here being exaggerated, he may be more convinced by the mere mention of Ailanthus and Japanese Honeysuckle, two plants which have since altered completely the scenery of many American cities and their countryside. The Japanese Honeysuckle was introduced toward the beginning of the



Fig. 6. The Chinese Wisteria became extremely popular in America soon after its introduction at the beginning of the 19th century.



Fig. 7. The Asiatic Deutzia is a very floriferous shrub introduced into America in the early 19th century.

nineteenth century but Ailanthus came earlier, as mentioned before, first in 1784 to The Woodlands. People now generally consider Ailanthus an undesirable tree, but for some time after its first introduction from China, in the 18th and early 19th centuries, it was one of the most planted and highly valued trees in Europe as well as in America. It was planted especially along the streets and was considered very ornamental with its large feathery compound leaves producing a tropical effect. In America, for instance, the several large Ailanthus, among the earliest introduced, were long regarded as outstanding trees in Humphrey Marshall's garden. In the early 19th century, forty-three kinds of native trees from all parts of the union grew in Independence Square together with seven foreign ones. These were all specially selected and considered as first class trees. These foreign trees were mostly of European origin, but there was also a "majestic" Ailanthus. The reverse of fortune came toward the late 19th century. Ailanthus began to fall into disfavor when it was accused of being overly aggressive for its root suckering and as offensive for the odoriferous pollen of the male trees when in flower.

### Introductions in the 19th Century

The trend of introducing exotic plants continued into the 19th century. In the Germantown area, Crape Myrtle and *Chimonanthus* or Wintersweet, were then in cultivation at the Wyck or Witt Garden. In the Evans' Arboretum at Bryn Mawr (started around 1828), many exotics were found including the Asiatic Yulan Magnolia and Cryptomeria. Although no list of plants was in existence, it was known that through exchange with Sir W. J. Hooker at Kew Gardens of England Evans obtained many rare plants from various parts of the world and through his son J. D. Hooker who explored the Himalayan Mountains, many Himalayan plants,

especially Rhododendrons, were introduced and planted there. Then the Painter's Arboretum, now Tyler Arboretum, through Evans, Meehan and many others, obtained various plants from abroad. Of the exotics there, Ginkgo, Cryptomeria and Magnolias were among the most notable. The Chinese and Japanese Snowballs, Wisterias and Deutzias, introduced in the early 19th century, soon became extremely popular in American gardens. (Figs. 5, 6 and 7).

The extent of the use of Asiatic plants in American gardens toward the mid-19th century can be seen in Thomas Meehan's "The American Handbook of Ornamental Trees," 1853, describing primarily all the trees then growing in Bartram's Garden. The trees of eastern Asiatic origin are listed below (the names being here rendered in modern nomenclature):

| | |
|---|---|
| *Ailanthus altissima* | Tree of Heaven |
| *Albizzia julibrissin* [3] | Mimosa Tree[3] |
| *Broussonetia papyrifera* | Paper Mulberry |
| *Cryptomeria japonica* | Cryptomeria (Fig. 8) |
| *Ginkgo biloba* | Maidenhair Tree |
| *Hibiscus syriacus* | Shrubby Althea |
| *Koelreuteria paniculata* | Goldenrain Tree |
| *Lagerstroemia indica* | Crape Myrtle |
| *Magnolia Soulangeana* | Saucer Magnolia (Hybrid Chinese Magnolia orig. 1820 in France) |
| *Malus spectabilis* | Chinese Crabapple |
| *Morus alba* | White Mulberry |
| *Prunus persica* | Peach |
| *Salix babylonica* | Weeping Willow |
| *Sophora japonica* | Chinese Scholar Tree |
| *Thuja orientalis* | Oriental Arbor-Vitae |
| *Thuja orientalis flagelliformis* | Oriental Arbor-Vitae, a weeping form |

The Meehan's Nursery in Germantown played an important role in the introduction of exotic plants into the American gardens in the nineteenth century.

### Asiatic Economic Plants

Besides ornamental trees and flowers, Philadelphia was first in the introduction of many Asiatic economic plants into this country. Here in Fairmount Park, Lemon Hill is so named because of its first introduction of Lemon trees into American gardens. There in the hot houses were also grown Oranges, Shaddock, Tea plant, and other economic plants from China and other parts of Asia.

[3]See cover illustration. This Albizzia tree along 7th street in Oak Lane is claimed to be the largest on record in this country.

Although the practice is now largely a thing of the past, oranges and lemons were so popular during the early 18th century, that special houses called orangeries were built to shelter them in the winter. The trees, kept dwarf by severe pruning, were planted in wooden tubs, which could be carried out in the summer to decorate the garden. At Lemon Hill there was an orange garden, bordered with box, set in turfed squares with walks. The owners of orangeries at that time were content if they ripened a few miserable oranges or lemons in a year. It is recorded that Philadelphia was astonished when the gardener at Lemon Hill picked two wash tubs of lemons to make that atrocious drink called lemonade for a party. With the coming of the first railroads, citrus fruits were imported from the south and the orangeries passed out of existence. (Fig. 9).

Other Chinese plants were introduced into America for economic purposes. Franklin, who sent soy bean seed to Bartram, was probably the first to introduce this most important Chinese plant to America. The Chinese White Mulberry was introduced into Long Island for raising silk



Fig. 8. Cryptomeria is an ornamental conifer introduced from eastern Asia in the early 19th century. This is the var. 'Lobbii'.



Fig. 9. Orangeries were popular in Philadelphia in the 18th century, after the European fashion. This one, of the Palace of Versailles, France, still extant, was built in the 17th century.

worms and vast plantations were in existence in the late 18th century. In 1830 interest and practice were so universal that cuttings were used as currency at 12½ cents. The mulberry speculation, started in 1825, lasted until 1844 when the cold winter and disease destroyed the last plantations. Old trees, however, scattered over various parts of the country, still exist as relics of this mulberry mania. The Chinese Paper Mulberry (*Broussonetia papyrifera*) was for some time also much esteemed as an ornamental tree. Its erstwhile popularity soon faded and like the Ailanthus its fate reminds us the changing fortunes of plants. Tender plants were also imported early for ornamental purposes such as Indian Azaleas, Oleander, Camellia and Chinese Hibiscus, which were cultivated in pots and used outdoors like Geraniums. Toward the middle of the 19th century, Camellia was the flower of flowers, in France and England, as well as in America, and is used extensively as corsage and bouquet even to this day. Before Horticultural Hall was demolished, visitors could see a specimen of Sago Palm, *Cycas revoluta,* from southern China, originally owned by Robert Morris before and during the Revolutionary War.

### Relations of the Asiatic and American Floras

Since we are considering the influence of Oriental plants on early American gardens, we may well end our discussion at the middle of the last century. But mention must be made of two facts made known at about this time that had great effects on American horticulture and gardening. One was Asa Gray's studies on the relationships between the floras of eastern North America and eastern Asia, particularly China and Japan. Many genera of plants, such as *Magnolia, Liriodendron, Wisteria* and *Pachysandra,* to mention but a few, are found only in these two distant regions and nowhere else in the world. Various geological and paleogeographic factors, especially the effects of the last glaciation, brought about this unique relationship.

Because of the basic relationship and similarity in climate and other physical conditions, most plants of eastern Asia thrive in eastern

North America when introduced into the gardens. The success of these eastern Asiatic plants in North America can be most vividly demonstrated by Ailanthus and Japanese Honeysuckle. Many other plants from eastern Asia frequently escape from cultivation and seed freely, becoming part of the naturalized flora, such as Paulownia, (Fig. 10), White Mulberry, Paper Mulberry and Hibiscus.

### Explorations in China

At about the same time, in the mid 19th century, another important event occurred in horticulture. China and Japan were opened up to the western countries. The epic journey made by Robert Fortune in 1848 revealed to the world for the first time the extraordinary horticultural wealth of China. This was followed by many other famous botanical explorers, such as Augustine Henry, Père A. David, Père Delavay and many others, whose efforts added greatly to our knowledge of the rich flora of eastern Asia and at the same time enriched abundantly the gardens of the world.

These two events occurring toward the middle of the 19th century opened up a new and vigorous chapter in the history of gardening of the world. And America was beginning to play an increasingly more important role in horticulture and gradually took over the lead from Europe. From the end of the 19th century onward, many botanical explorers such as E. H. Wilson, Frank Meyer and J. F. Rock, to name but a few of the best known, have brought back from the mountainous regions of China and Japan numerous beautiful plants hitherto unknown to the gardens. And so, up to today, many more Asiatic plants are planted in the gardens of Europe and America than native plants from these regions combined. The early Pennsylvania gardens have played a not insignificant role in all these achievements.



Fig. 10. The majestic Paulownia, introduced in the early 19th century, is now naturalized in the eastern United States.

## New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since December, 1958:

Bloodgood Nurseries Inc.
Mrs. Henry W. Bousman
Miss Hebe Bulley
Mr. and Mrs. Robert E. Coughlin
Miss Phoebe Crosby
Mrs. George E. DeCoursey
Mrs. Edward J. Fleming
Mr. Thomas F. Galante
Dr. George H. Geuting
Mr. Harris J. Grebe
Mrs. George R. Haines
Mr. Norman V. Holmes
Mrs. Howard C. James
Mrs. C. Henry Landenberger
Mr. Harry F. Mazaleski
Mr. Warren E. Miller
Mr. and Mrs. Ray Ollis, Jr.
Mr. Robert Gwynne Stout
Ward and Cromie
Mrs. C. R. Whittlesey

# Bisexual Conelets in Spruce

FRANK S. SANTAMOUR, JR.[1]

Coniferous tree species, including the spruces, are usually monoecious in flowering habit; that is, both purely male and purely female conelets[2], are borne on the same tree. Occasionally, however, abnormal structures occur in which both male and female organs are found in the same conelet.

Although such bisexual conelets have been reported in most genera of the Pinaceae, most of the reports deal with the finding of only one or a few bisexuals on a tree. The discovery of numerous bisexual conelets on *Picea montigena* Masters, in the spring of 1958, prompted a survey of all the spruce species growing in the Philadelphia area that are used in forest genetics research by the Northeastern Forest Experiment Station. Specimens of 25 species were examined and, of the 17 species that fruited in 1958, a total of 11 trees representing 7 spruce species was found to bear bisexual conelets (Table 1).

TABLE 1. — THE PRODUCTION OF BISEXAL CONELETS AND POLLEN ABORTION IN SEVERAL SPRUCE (PICEA) SPECIES

| Species | Trees | Bisexual conelets/tree | Pollen abortion | |
|---|---|---|---|---|
| | | | Normal conelets | Bisexual conelets |
| | *Number* | *Number* | *Percent* | *Percent* |
| *asperata* | 2 | c.50,500+ | 1 | 10 |
| *Balfouriana* | 1 | 25 | – | — |
| *glauca* | 3 | c.10 | 1 | — |
| *montigena* | 2 | 500+ | 2 | 40 |
| *retroflexa* | 1 | 13 | 6 | 16 |
| *Smithiana* | 1 | 24 | 4 | 35 |
| *Wilsonii* | 1 | 33 | – | 52 |

## CHARACTERISTICS OF CONELETS

The bisexual conelets of all species examined except *P. Smithiana* Boiss. (Himalayan spruce) were essentially of the same type. Male tissues occurred on the lower portion of the conelet and the female tissue occupied the tip in varying proportions (Fig. 11). Although some variation was encountered on each tree sampled, the average proportion of female tissue to the length of the conelet was 1/5 for *P. montigena, P. Wilsonii* Masters, and *P. asperata* Masters; 1/4 for *P. Balfouriana* Rehd. and Wilson; and 1/2 for *P. glauca* (Moench) Voss (white spruce). Even though some bisexuals were erect, as the normal female is, all appeared to be basically male.

In the *P. Smithiana* conelets examined, female tissue always occurred at the base and was usually present at the tip. Some of the conelets were predominantly female (Fig. 12, B, C) while others were essentially male (D, E). The transition zone between male and female tissue was irregular in *P. Smithiana* but abrupt in the other species.

Some degree of separation of the sexes is common in the crowns of spruce; female conelets are usually concentrated in the upper portion and male conelets in the lower portion. The bisexual conelets were found in all but the topmost section of the trees. Some other interesting observations: *P. retroflexa* bore no purely female conelets; and on *P. Wilsonii,* which likewise had no pure females, almost the entire crop was bisexual.

## POLLEN ABORTION

Just before anthesis a number of normal male and of bisexual conelets of the various species were collected and allowed to shed pollen in the laboratory. Pollen slides were made with glycerine jelly and the degree of pollen abortion



Fig. 11. A female conelet of *Picea montigena* (left), compared with two bisexual conelets.

[1]The author is a geneticist of the Northeastern Forest Experiment Station, U. S. Forest Service. He is stationed at the Morris Arboretum of the University of Pennsylvania, where the Experiment Station and the Arboretum cooperate in genetics research.

[2]The reproductive structures of conifers are known variously as flowers, cones, conelets, catkins, and strobili. The term conelets is used in this paper.



Fig. 12. Normal and bisexual conelets of *Picea Smithiana*. *A* is a female conelet; *B, C, D,* and *E* are bisexual; and *F* is a male conelet.

was determined from 200 single pollen grains selected at random. The results (Table 1) show that pollen abortion was considerably higher in the bisexual conelets.

An additional abnormality of the "bisexual" pollen was noted in *P. asperata* and *P. Wilsonii,* 6 and 63 percent respectively of whose pollen was shed in the form of tetrads. The degree of abortion of these tetrads was essentially the same as that of the single grains and no instance of normal and aborted pollen occurring in the same tetrad was found. The individual pollen grains of the good tetrads were normal in most respects, with well-developed wings, and the nuclei were stainable with aceto-carmine.

Pollen samples taken from the base, middle, and tip sections of bisexual conelets of *P. montigena* and *P. asperata* showed no consistent differences in degree of pollen abortion. Thus the physiological disturbances resulting in pollen abortion do not appear to be affected by position in relation to the female tissue.

## Cone Maturation

Mature cones developed from bisexual conelets only on *P. Smithiana.* The three mature cones found were all derived from the same conelet type: that with only a small collar of male tissue near the middle of the conelet (Fig. 12, B). Survival and maturation of these aberrant conelets apparently depends to a large extent on the amount of female tissue present. In all species the length of time the conelets appeared to be functional, as judged from color and freshness, varied according to this factor.

Seed extracted from the three bisexual cones was of normal size, but no filled seed was found. Likewise, none of the seed extracted from normal cones was filled. This is not surprising, since no other trees of the same species occur nearby. It may be inferred, however, that the disturbed physiology of the bisexual conelets does not render them any more susceptible than normal conelets to natural self-fertilization or to hybridization with *P. glauca* and other species that were shedding pollen during the receptive period of *P. Smithiana.*

## Discussion

Since no bisexual conelets had been noted on the trees studied during 10 years of observation prior to 1958, it seems unlikely that such conelets are a normal or common occurrence. No definite conclusions can be offered as to the cause of this apparent outbreak of bisexuality.

Of the 7 species that bore bisexual conelets, 5 are native to China, 1 to the Himalayas, and 1 to North America. They represent 2 of the 3 sections of the genus *Picea,* and the individual specimens range in age from 25 to 35 years. With the exception of *P. glauca,* these species are rarely planted and are relatively unknown outside of arboretums.

Although it might be speculated that bisexuality is fairly common among the above exotics and simply has not been observed, the show of bisexuality in the American *P. glauca* in 1958, along with the exotics, casts doubt on such speculation. It seems more probable that the cause of the conelet abnormalities is largely environmental in character. The severe drought of 1957 may have been a major contributing factor.

# Book Reviews

A Field Guide to Trees and Shrubs, by George A. Petrides. Illustrated by the author and Roger Tory Peterson. Houghton Mifflin Company, Boston, 1958. $3.95.

Since the text in the Peterson Guide series devoted to Ferns was the most crudely written, inaccurate, and misleading ever published on these plants, it is a pleasure to report that the one on trees and shrubs is about the best ever devoted to them.

The area covered, northeastern and midland states and adjacent Canada, is the same as that of the 8th edition of Gray's Manual, and the technical nomenclature conforms to this work. The sequence of taxa is, however, wisely based on practical considerations of emphasizing resemblances rather than relationships, Another divergence, on the whole cleverly planned and applied, is the use of colloquial instead of technical terms, *e.g.*, "feather-compound" instead of the customary pinnate-compound.

The descriptions and the illustrated keys, with leaves printed in green, are excellently worked out, and should make identification of unknowns simpler and at the same time more certain than any similar book thus far published. The drawings, on which many users will of course depend, are nearly all accurate and realistic. It may merely be noted that the acorn of Scrub Oak is shown a bit large, and that the early leaves of Sour Gum may bear a few coarse teeth. In the text, however, there are slips which may be worth pointing out to help the user of this edition and suggest possible improvement of a second.

Actual typographical errors are exceedingly few; the reviewer noted "bell" for ball-shaped fruits of the Fringe-tree, and the misspelling "Ponciris" once, "Symplocus" three times, and "tips" instead of tip with the illustration of Tulip-tree. The color of Red Cedar fruit and Sweetleaf flower, and the features of the fruit of American Strawberry-bush do not accord with Gray's Manual. On the other hand this Manual is usually followed so closely that slips in it sometimes got copied, *e.g.*, that Sugar-maple leaves are normally hairless and that Small named the southern Sheep-laurel "caroliniana" (should read *carolina*). The author is manifestly not very familiar with the members of the Heath Family, and has misdescribed several of them. The flowers of Black Huckleberry are reddish, not "whitish," while those of Great Rhododendron are never "reddish", but mostly white to pinkish; those of Fetterbush are more often pink than white. The flowers of Labrador Tea are not "bell-like" but open-faced as shown indeed in the drawing on p. 282; the same holds for the Pepper-bushes. In Staggerbush the flowers are rarely pink, and are large, not "small;" those of Zenobia are the largest of the group, and so on.

One diagnostic character, rarely used in other works, is unfortunately unrealistically treated. In the text, starting on page 53 and repeatedly on many later pages, end-buds are characterized as "false," with "true" under other species, by way of comparison. Then in the illustrated keys, beginning on page 181, the terms "absent" vs. "present" are used for the same situation. Actually both sets of terms are erroneous; what the author means is evidently "offset" vs. "centered."

For prospective users of this Guide in Pennsylvania it should be pointed out that the geographic ranges given are faithful renderings of those in Gray's Manual, but that some of these were compiled many years ago. At least ten taxa not stated or implied to grow in this state are now well-known here: Northern Mountain Ash, (p. 87), Pachistima (172), Canada Buffaloberry (182), Northern Arrowwood (190), American Barberry (228), Balm-of-Gilead (240), Mountain Alder (254), Box Huckleberry (278), Mountain Pepperbush (284), and Dwarf Azaleas (265).

Edgar T. Wherry

Camellia Culture. Edited by E. C. Tourje. The Macmillan Company, New York, 1958, $11.50.

On the jacket, it is stated that this book is "A compendium of the latest scientific practices, described from their own experience by 55 of the country's leading research workers and Camellia growers". The contents are divided into nine topics: plantings; care of camellias; climate; propagation and development; display, shipping and handling; pests and their control; diseases and methods of treatment; soils, nutrition, and moisture; breeding and hybridizing. The 44 papers includes such wide-ranging subjects as "Where, how, and when to plant camellias", "Disbudding camellias", and "Air layering" to others like "Embryo culture in camellia seed germination", "Leaf studies", and "The use of ionizing radiation in plant breeding".

This is a useful reference work for professional camellia growers and research workers. The various papers, written by 55 different authors, are necessarily of different merit and each has to be evaluated individually. The contributors vary from professors and research scientists to nurserymen and "Camellia fanciers". Thus some of the papers are carefully documented and provided with bibliographies while others are not. If all had been brought to a uniform scholastic standard, the book would have been a more useful volume than it is.

This is a valuable contribution to the cultivation of the camellia. The editor might well use the wealth of information contained therein to present to the amateur camellia grower a digested and organized treatise on this same general subject.

H. L. Li

# Associates' Corner

In the last issue of the Bulletin we spoke of an outstanding local activity. As our Arboretum is international in its scope, a story of some of our East Indian contacts, which perhaps, we associates are not aware of, might be of interest.

When Dr. Fogg went to India in 1954 for two months, in search of drug plants for the Medicinal Garden at the Arboretum, among the many friends he made, were two young men in Southern India, who were exceedingly helpful to him. Dr. P. D. Varadarajan who was at that time engaged in botanical research at Madras University and Mr. P. V. Rajappan, who was employed as propagator at the Conoor Agricultural Experiment Station in the Nilghiris of Southern India.

Incidentally, India is exceptionally rich in drug species, over one thousand being incorporated into the three great schools of Indian Medicine, which have existed for many centuries.

Dr. Fogg invited these two gentlemen to visit the Arboretum for a year to work with him on certain problems relating to the cultivation of medicinal plants.

Dr. Varadarajan arrived in the Spring of 1956 and spent ten months at the Arboretum, studying the taxonomy and diseases of various species of drug plants and their reaction to their American environment.

His keen understanding and knowledge of Indian plants and their uses in the Indian Schools of Medicine, have been of tremendous help to the Arboretum. In return, his experiences here have enabled him to find employment, on his return to India in 1957, with a large pharmaceutical concern, which sends him all over that vast country in search of more useful plants. He writes frequently to say that he is still homesick for the Arboretum and especially for its snow-covered hills in winter.

Mr. Rajappan arrived early in the summer of 1956, bringing with him a gift for our Library, of a fine collection of books and pamphlets on Indian Botany and Horticulture. Language is no barrier in this case, as there are several East Indian students at the University of Pennsylvania.

Mr. Rajappan also brought or sent seeds, roots, and bulbs of many plants used in Indian medicine. These have been grown and propagated at the Arboretum, greatly enhancing our valuable collection of drug plants. At the end of the year, Mr. Rajappan went to Cornell University where he is persuing his studies for an advanced degree in Horticulture. Both of our guests have assured us that the opportunity to study American botanical and horticultural methods will be of inestiminable value to them in their subsequent careers in India.

So, our Arboretum, sitting quietly on the Banks of the Wissahickon, is doing its bit towards a better understanding amongst the Nations of the World.

Marion W. Rivinus

# Arboretum Activities

(*Continued from Page 2*)

Dr. Patricia Allison, Pathologist, in addition to her research activities at the Arboretum, is conducting a course in General Mycology at the Department of Botany on the campus.

## Bonsai Meeting

On Saturday afternoon, February 14, about 30 persons gathered at the Arboretum to witness a demonstration of bonsai methods presented by Mr. Yuji Yoshimura of Tokyo. Mr. Yoshimura is co-author of a recently published book entitled "The Japanese Art of Miniature Trees and Landscapes: Their Creation, Care and Enjoyment." Several of those who attended the meeting brought with them their own bonsai specimens and profited greatly by Mr. Yoshimura's constructive criticism of their material.

## Plant Distribution

As previously announced in these pages, the annual distribution of plants to our Associates has been shifted from Autumn to Spring. The dates which have been set for this event are Friday and Saturday, May 22 and 23. Well in advance of these dates our associates will receive an announcement together with a list of the varieties which will be available.



Fig. 13.




Fig. 14.

## Flower Show Exhibit

At the invitation of the Pennsylvania Horticultural Society, the Arboretum prepared an exhibit of Dwarf and Low-growing Conifers for the Philadelphia Flower Show which was held during the week of March 9. The increasing popularity of miniature Conifers reflects not only their intrinsic attractiveness but the desire of many home owners to achieve an interesting result within a limited space. Many of the forms displayed lend themselves to effective treatment as rock garden subjects; others may be utilized in foundation plantings or as groupings on a bank or along a driveway or walk.

Several of the specimens in the exhibit were obtained from Henry Hohman's Nursery at Kingsville, Maryland, others were due to the generous cooperation of Mr. Fred Bergman of Kensington Avenue, Philadelphia, who allowed us to borrow them for the show. (Figs. 13 and 14).[1]

Major credit for this exhibit must go to Miss Mary Milton, Propagator and Mr. John Tonkin, Superintendent. These two members of the staff assembled the material and worked out their arrangement in our display.

Following is a list of the material included in the exhibit:

Abies balsamea nana
Abies procera glauca prostrata
Cedrus Deodara pendula
Cedrus libani nana
Chamaecyparis Lawsoniana Forsteckensis
Chamaecyparis Lawsoniana grandis

[1] Photographs by E. B. Gilchrist, Jr.

Chamaecyparis Lawsoniana minima glauca
Chamaecyparis obtusa lycopodioides
Cryptomeria japonica Jindai-sugi
Cryptomeria japonica monstrosa nana
Juniperus communis compressa
Juniperus recurva Coxii
Juniperus Shimpaku nana
Juniperus squamata
Picea Abies Clanbrasiliana
Picea Abies conica
Picea Abies cupressina
Picea Abies gracilis nana
Picea Abies Gregoryana
Picea Abies Maxwellii
Picea Abies mucronata
Picea Abies nidiformis
Picea Abies Ohlendorffii
Picea Abies procumbens
Picea Abies pygmaea
Picea Abies pumila
Picea Abies Remontii
Picea Abies repens
Picea mariana Doumettii
Picea mariana nana
Pinus Mugo rostrata
Thuja occidentalis ericoides
Thuja occidentalis Hetz's midget
Thuja occidentalis Ohlendorffii
Thuja occidentalis plicata dumosa
Thuja orientalis decussata
Thujopsis dolabrata nana
Tsuga canadensis albo-spica
Tsuga canadensis Bennet
Tsuga canadensis Bennet #10
Tsuga canadensis cinnamoma
Tsuga canadensis Curtis spreading
Tsuga canadensis Hushii
Tsuga canadensis Jervis
Tsuga canadensis Joe Gable #2
Tsuga canadensis Joe Gable #5
Tsuga canadensis Kingsville #1-B
Tsuga canadensis Lewis
Tsuga canadensis minima
Tsuga canadensis Von Helm

J. M. F., Jr.

# Morris Arboretum Bulletin

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# Arboretum Activities

## The Staff

The Director has for several years been a member of the Visiting Committee for the Arnold Arboretum of Harvard University. Twice each year (in early May and October) the members of this Committee spend a day at the Arboretum in Jamaica Plains, Mass., inspecting the plantings and learning of work in progress. Because of the close association which has long existed between the Morris Arboretum and the Arnold this opportunity for a continuing intimate relationship is greatly valued.

Dr. H. L. Li, Taxonomist, has recently returned from two months in the Far East where he was continuing his studies on the trees and shrubs of Formosa. After visiting Hong Kong and Formosa, each for about a week, Dr. Li went on to Japan where he spent the major portion of his time studying in the herbarium at Tokyo University. He also worked for a while with the collections at Kyoto. In a future issue of the Bulletin Dr. Li will give an account of some of the botanical highlights of his trip.

(*Continued on Page 31*)

# Hard Pines Cultivated in the Philadelphia Area

Jonathan W. Wright and Frank S. Santamour, Jr.[1]

## Introduction

*Pinus* is the largest and most important genus of conifers. In fact it is one of the half dozen most important plant genera in the world. The pines produce much more than the knotty pine panelling with which we decorate our recreation rooms. They furnish the majority of the lumber used in house construction — the beams which support the floors, the rafters in the roof and the joists in the walls. They may also supply subflooring, flooring, and siding. The majority of our telephone and power line poles are made from pine trees. Pine wood pulp is the mainstay of the southern pulp industry which supplies the raw material for newspapers, facial tissues, cardboard cartons, and rayon clothing. Large quantities of pine piling are used to support houses, office buildings, and harbor works. And the southern pine naval stores industry furnishes turpentine and resin. If all pine products were to be suddenly taken away from us, we should probably have to revise our living habits just as much as if we were suddenly to lose our automobiles.

The landscape possibilities of the genus are equally varied. No pine can furnish the pretty flowers of the rose or the red autumn foliage of the maple. But the evergreen foliage and the varied trunk sizes and shapes furnish backgrounds against which to display summer flowers and may provide all the color there is in the winter garden.

The hard pines, which are the subject of this paper, grow in a variety of shapes and sizes to fulfill many landscaping needs. At one end of the scale is the mugo pine (*P. Mugo* Turra. var. *Mughus* (Scop.) Zenari) which is a shrub that commonly grows only a few feet tall. It is ideal for foundation plantings. The Japanese umbrella pine (*P. densiflora* Sieb. & Zucc. var. *umbraculifera* Mayr.) is another shrubby type. It has yellow-green foliage and a delightfully crooked, orange-red trunk. (Fig. 18). There are several species, for example Virginia (*P. virginiana* Mill.) and Table-Mountain (*P. pungens* Lamb.) pines which form round-topped, much-branched trees 20 to 40 feet tall when open-grown. They can form the focal point for groupings of shrubs and flowers in small gardens. Lastly there are the many species such as red (*P. resinosa* Ait.), Scotch (*P. sylvestris* L.), (Fig. 15), European black (*P. nigra* Arnold) (Fig. 16), and ponderosa (*P. ponderosa* Laws.) pines which have straight, single stems and grow to large sizes. They are useful for snowbreaks and shade, and as specimen trees in large gardens and parks.

## Geographic Origins of Philadelphia's Hard Pines

The hard pines are widely distributed in the northern hemisphere. In the New World they occur naturally from Nova Scotia westward across Canada to Alaska, south to Guatemala, and on many of the Caribbean islands. In the Old World their natural range extends from north of the Arctic Circle in Scandinavia and Siberia to Turkey and northern Africa and eastward across Asia to Japan and the Philippines. Their southernmost natural occurrence is a few miles south of the equator in Sumatra. This range has been greatly extended by man's activities and now there are hundreds of thousands of acres of pine plantings in southern Africa, Chile, New Zealand, and Australia.

The forests of the northeastern United States contain eight indigenous hard pines. These are red pine, jack pine (*P. Banksiana* Lamb.) Table-Mountain pine, Virginia pine, shortleaf pine (*P. echinata* Mill.), pitch pine (*P. rigida* Mill.), loblolly pine (*P. Taeda* L.), and pond pine (*P. serotina* Michx.), All of these except the Table-Mountain and pond pines are important timber or pulpwood species in Pennsylvania, New Jersey, and Maryland and all except the pond pine are represented in the Philadelphia area by living, healthy specimens. However, only red pine has been planted to any extent within the city and its suburbs.

The extensive pine forests of the southeastern United States are composed of four principal species — shortleaf pine (New York and southward), loblolly pine (Cape May, New Jersey and

[1] Dr. Wright is Associate Professor of Forestry, Michigan State University, East Lansing, Michigan. Most of the observations recorded in this paper were made when he was Geneticist at the Northeastern Forest Experiment Station of the U. S. Forest Service (1946-1957). Mr. Santamour is Geneticist, Northeastern Forest Experiment Station, and has been stationed at the Morris Arboretum since 1957. The forest genetics work of the Northeastern Station is in cooperation with the Morris Arboretum of the University of Pennsylvania at Philadelphia, Pennsylvania.



Fig. 15. Scotch pine, *Pinus sylvestris*

southward), longleaf pine (*P. palustris* Mill., Virginia and southward), slash pine (*P. Elliottii* Engelm. var. *Elliottii,* South Carolina to Louisiana), and South Florida slash pine (*P. Elliottii* var. *densa* Little and Dorman). The four northernmost of these species are represented in Philadelphia by living specimens. Neither of the two minor southern pines — pond pine and sand pine (*P. clausa* (Chapm.) Vasey, Florida and Alabama) has been planted here.

In the mountainous forests of the western United States and Canada there are seven hard pine species that have proved hardy in Philadelphia. They are ponderosa pine, lodgepole pine (*P. contorta* Dougl.), Jeffrey pine (*P. Jeffreyi* Grev. & Balf.), Apache pine (*P. Engelmannii* Carr.), Digger pine (*P. Sabiniana* Dougl.), Chihuahua pine (*P. leiophylla* Schiede & Deppee var. *chihuahuana* (Engelm.) (Shaw), and knobcone pine (*P. attenuata* Lemm.). The first four of these, which grow in regions with cold winters, show promise of becoming useful timber and ornamental trees in the Northeast. The newly described Washoe pine (*P. washoensis* Mason & Stockwell) from the mountains of western Nevada has not yet been tested here but will probably prove hardy. Three other native United States species — Monterey pine (*P. radiata* D. Don), bishop pine (*P. muricata* D. Don), and Torrey pine (*P. Torreyana* Parry) — grow naturally in the warmer parts of California or Baja California and probably will not prove hardy in the eastern United States.

The Mexican highlands are the center of genetic diversity in the genus, containing 30 or 40 different pine species. Many are useful timber types within their native ranges and are being planted extensively in the southern hemisphere. Unfortunately they seem to be of little potential value for Pennsylvania conditions. Several years ago we obtained seeds of six Mexican species and grew them in the nursery at the Morris Arboretum. The seed germinated well and the seedlings grew rapidly. But only one seedling survived as long as three years, the majority dying the first winter.



Fig. 16. European black pine, *Pinus nigra*

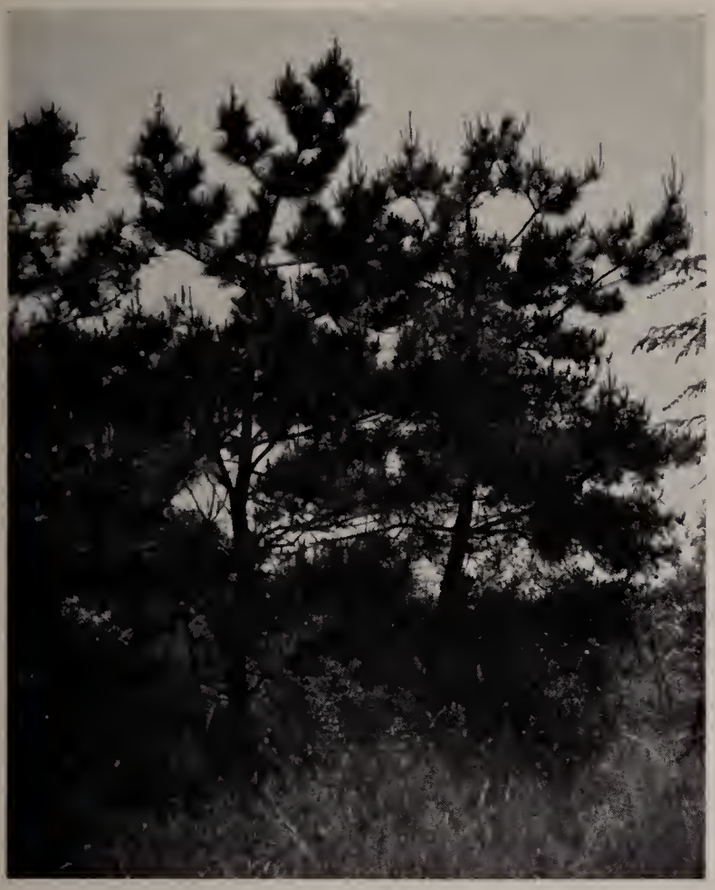


Fig. 17. Japanese black pine, *Pinus Thunbergii*

The three hard pine species which are most commonly planted in this area are introductions from northern and central Europe. These are Scotch pine, Austrian pine (*P. nigra* Arnold var. *austriaca* (Hoess) Aschers. & Graebn.), and mugo pine. Only a single specimen of *P. Heldreichii* Christ from the mountains of Greece is known to exist in this area. The cluster pine (*P. Pinaster* Ait.) is a recent introduction from Spain and Morocco. It has proved unexpectedly hardy and fast-growing. The sixth native European species, Aleppo pine (*P. halepensis* Mill.), lasted only one growing season when tested at the Morris Arboretum several years ago. The nut pine (*P. pinea* L.) from the shores of the Mediterranean Sea is still untested in Pennsylvania.

Japan, which is a center of diversity for many genera, contains only two hard pine species — Japanese red pine (*P. densiflora* Sieb. & Zucc.) and Japanese black pine (*P. Thunbergii* Parl.). (Fig. 17). Both are well adapted to Philadelphia conditions. They grow rapidly and produce seed at an early age and also reproduce naturally in several situations.

China, like Japan, is relatively poor in pine species. The Chinese pine (*P. tabulaeformis* Carr.) is a wide ranging and variable species from the mountains of western China. In Philadelphia it is represented by a few specimens, some of which show considerable promise as timber trees. (Fig. 19). The Masson pine (*P. Massoniana* Lamb.) and Yunnan pine (*P. yunnanenis* Franchet) are doubtfully present in this area. The specimens in the Morris Arboretum certainly contain germplasm of the two species in question but may be interspecific hybrids rather than the pure species. (Fig. 20).

The remaining hard pine species (about six in number) are natives of warm regions such as the Canary Islands, the Ryukyu Islands, Formosa, the Philippines, southeast Asia, Sumatra, India, and Pakistan. There are no records of their having been tried in Philadelphia and only the chir (*P. longifolia* Roxb.) from the mountains of India and Pakistan is likely to prove hardy here.

To sum up, most of the successful hard pine introductions have come from the northeastern United States, the mountainous parts of the western United States, northern and Central Europe, Japan, and Western China. For the most part the many species native to the southeastern United States, coastal California, Mexico, the coastal areas around the Mediterranean, and southeastern Asia are not hardy in our area.



Fig. 18. Japanese umbrella pine, *Pinus densiflora* var. *umbraculifera*

## Racial Variation in the Hard Pines

About 140 years ago Roger Vilmorin, a French seedsman, obtained seeds of Scotch pine from different parts of the species' natural range and grew the resulting seedlings on his estate near Nancy, France. He then transplanted the seedlings to as nearly a uniform a site as he could find. These plantings form the nucleus of the present Arboretum des Barres. But, more pertinent to the present discussion is the fact that his tests showed the immense amount of genetic variation contained within a single Linnaean species. Some of his origins grew twice as fast as others, and there were important differences in cone size, needle color, and trunk form.

Vilmorin's results were published in 1857. They prompted other European investigators to undertake similar studies. By the end of the 19th century the presence of racial variability had been established in several European species and it was common practice for European foresters to specify the general areas from which they wished to obtain seed for planting in a certain locality. However, it was not until the mid-1920's that American foresters became seriously interested in the problem of racial variability. At that time a small seed origin study of loblolly pine was established in Louisiana. Like its European forerunners, this test showed that growth rate, disease resistance, and other characters varied with the locality from which the seed was collected. By 1950 seed origin studies were under way in about 15 different hard pine species and planned in several others (Schütt, 1958). In all but one of these 15 species the presence of genetic differences has been demonstrated. Here we can mention only a few of the most important studies dealing with species that are commonly planted in the area.



Fig. 19. Chinese pine, *Pinus tabulaeformis*

The importance of seed origin in forest trees is best illustrated by reference to data from a 17-year-old Scotch pine planting in southern New Hampshire (Wright and Baldwin, 1957). This planting was established in 1938 as part of a cooperative international test and contains trees from 55 different localities in northern and central Europe. Each of these localities was represented by two or more plots of trees, so that we can be sure that the reported differences are due to the origin of the seed and not to soil differences. The trees were measured in 1955, during their 18th growing season. The following tabulation shows the most important characteristics of some of these seed origins at that time (all differences shown are statistically significant).

| Locality of origin | Height | Trunk straightness | Winter foliage color |
|---|---|---|---|
| | *Feet* | | |
| Northern Norway | 6 | Straight | Yellow |
| Southern Sweden | 14 | Straight | Yellow-green |
| Latvia | 19 | Straight | Green |
| Germany | 20 | Crooked | Green |
| Belgium | 23 | Crooked | Blue-green |

The Latvian stock is best from the forester's standpoint because of its moderately rapid growth and straight stems. That stock is also good for Christmas tree growers although many people prefer the slightly bluer Belgian trees.

Several small seed origin studies conducted with the European black pine indicate that it is just as variable as the Scotch pine. Several years ago we tested nine different European black pine seedlots in the Northeastern Forest Experiment Station's experimental nursery at the Morris Arboretum and could probably have described nine different varieties had we been so inclined. At the end of 2 years some seedlots were only 3 inches tall and had straight needles. Some were 6 or 7 inches tall and had straight needles. Others were 8 or 9 inches tall and had curly needles. No wonder that 105 different scientific names have been proposed for parts of this one species! At the present time only the Austrian variety of this species is commonly planted in the United States, but some of the other varieties may prove to be far more satisfactory.



Fig. 20. Masson pine, *Pinus Massoniana*

A recently established seed origin test of jack pine is now in its sixth growing season. Already this test has produced one astonishing result. Trees from Michigan's lower peninsula grow about 20% faster than do trees from Michigan's upper peninsula even though the two populations are separated only by the narrow Mackinac Straits. Differences in resistance to insect pests were also noted.

Most of our knowledge concerning racial variability in the western ponderosa pine was obtained from a 20-year-old planting established in northern Idaho. In that test trees from western Montana (21 feet tall, 4.6 inches diameter breast high) grew over twice as tall as did trees from northern New Mexico (10 feet tall, 2.2 inches diameter breast high). Differences as pronounced as these were also evident in trunk form, crown form, needle arrangement, and needle number (Weidman, 1939).

Unfortunately we do not know the geographic origins of many of the trees planted around Philadelphia. They may be among the best or among the worst available in the species. This situation is being remedied rapidly and a decade from now tree planters can expect much better results by planting seed of the best origins of the best species.

## Taxonomy and Identification of the Hard Pines

The genus *Pinus* is separated into two subgenera — the soft pines or subgenus HAPLOXYLON and the hard pines or subgenus DIPLOXYLON. Some of the more important characteristics by which these subgenera may be identified are shown in the following tabulation.

| | Haploxylon | Diploxylon |
|---|---|---|
| Leaf fascicle sheaths | Deciduous | Persistent |
| Bracts of leaf fascicles | Not decurrent | Decurrent |
| Fibrovascular bundles per needle | One | Two |
| Stomata on back of needle? | Usually not | Yes |
| Umbo on cone scale | Terminal and resinous in many species | Lateral, not resinous |
| Male flowers formed | Shortly before anthesis | The season before anthesis |

The subgenus DIPLOXYLON is further subdivided into several series (seven according to Shaw, 1914, and Rehder, 1940; more according to Martinez, 1948). With a few exceptions these series comprise natural groups of species with common characters and similar geographic ranges. Hybridization studies also indicate the general validity of the series (Duffield, 1952; Wright and Gabriel, 1958). Nearly all attempted crosses involving members of different series have failed (the exceptions are *P. echinata* × *P. rigida* and *P. Jeffreyi* × *P. Coulteri*) whereas a large percentage of the crosses made within series have succeeded.

Most current estimates place the number of species in the genus at between 80 and 90. If anything these estimates are too low. There is considerable merit in recognizing some entities that are now termed geographic varieties or races as distinct species. Such splitting would make for a more uniform species concept in all the conifers. It would also serve a practical purpose by insuring that tree planters paid proper attention to the source of their seed. For example, there is no doubt but what the dwarf (*P. Mugo* Turra. var. *Mughus* (Scop.) Zenari) and erect (*P. Mugo* var. *rostrata* (Ant.) Hoopes) forms of the European mountain pine are genetically different and are useful for different purposes. At present some tree planters make the mistake of ordering one when they want the other. Mistakes of this type would be less common if the two were regarded as separate species.

There are no rigid rules governing the choice of characters to use in identification work. In our own studies, which have been concerned largely with the recognition of young hybrids, we have used foliage odor (useful in distinguishing Japanese red pine, Japanese black pine and their hybrids), bud color, bud diameter (useful in distinguishing *P. Thunbergii* × *P. nigra* from pure *P. Thunbergii*), growth rate, needle number, foliage color, cone color, degree of cone opening, and whether or not the first-year buds were hidden by the needles. Mirov (1946) found

that many pine species could be identified as exactly (but not as quickly) by the chemistry of their turpentines as by structural characters. In other words, diagnostic characters are where you find them, and do not follow any pattern laid down by a consideration of whether or not one type of structure is more stable than another.

Table 1 is a key to the series and species which are now grown in the Philadelphia area. In preparing this key we tried to stress characteristics which are easily visible on young as well as on old trees. The keys were prepared from Little (1957), Martinez (1948), Rehder (1940), Sargent (1905), Shaw (1914), and our personal acquaintance with the species.

Table 1. Key for the identification of series and species of hard pines growing in the Philadelphia area.

KEY TO SERIES[2]

A. Cones requiring 3 years for development; leaf-sheaths deciduous; leaves 3 and 4 per bundle. LEIOPHYLLAE

A. Cones requiring 2 years for development; leaf-sheaths persistent; leaves 2 or 3 per bundle.

B. Seeds less than ¾ inch long, shorter than the membranous wings.

C. Cones unarmed, 1 to 4 inches long, dehiscent at maturity and easily detached from the branch; leaves 2 per bundle (except in *P. yunnanensis*), 2 to 8 inches long; spring shoots uninodal; trees from Eurasia or northeastern United States, inhabiting moderately well drained soils. SYLVESTRES

CC. Cones armed, 2 to 10 inches long, dehiscent at maturity and easily detached from the branch; leaves usually 3 per bundle (except in *P. echinata* and some geographic varieties of other species), 3 to 18 inches long; spring shoots uninodal (western United States species) or multinodal (southeastern United States species). AUSTRALES

CCC. Cones armed (except in *P. Banksiana*), tenaciously persistent and often serotinous, 1 to 6 inches long; leaves 2 or 3 per bundle, 1 to 10 inches long; spring shoots multinodal. INSIGNES

BB. Seeds ¾ inch long, longer than the thick wings. MACROCARPAE

[2] Several characters used in this key apply only to species grown in Philadelphia and not to all species in the series.

KEY TO SPECIES

A. Leaves 2 per bundle (sometimes 3 in *P. pungens, P. tabulaeformis*).

B. Terminal buds unbranched; spring shoots uninodal; cones opening when mature (except in *P. Pinaster*).

C. Young branchlets covered by bloom, less than ⅛ inch in diameter; leaves slender; cones unarmed, with a weak hold on the branch.

D. Leaves 4 to 8 inches long, yellow-green; rare in the Northeast. *P. Massoniana*

DD. Leaves 3 to 5 inches long, bright green; cones 1½ to 3 inches long, often borne on young trees; staminate catkins yellow, less than ¼ inch long before anthesis; buds brown, non-resinous, with fimbriate scales; bark orange-red; moderately common in Philadelphia. *P. densiflora*

CC. Branchlets without bloom.

D. Cones armed with stout prickles, 3½ to 7 inches long, persistent; leaves 4 to 8 inches long, dark lustrous green; branchlets red brown; buds brown, not resinous; rare in the Northeast. *P. Pinaster*

DD. Cones unarmed, 1 to 3 inches long, usually not persistent or with a weak hold on the branch.

E. Leaves gray-green, 1 to 3 inches long, twisted; buds gray, very resinous; branchlets yellow-gray; cones conic, grayish, with pyramidal apophyses; male catkins yellow, less than ¼ inch long before anthesis; bark orange-red, breaking into thin scales; common in Northeast. *P. sylvestris*

EE. Leaves dark green; male catkins reddish, more than ¼ inch long.

F. Leaves breaking when bent, slender, flexible, not sharp-pointed, 5 to 7 inches long; buds resinous, light brown, frequently killed by shoot moths; bark of old trees red-brown; cones conic-ovid, 1½ to 2½ inches long; common in the Northeast. *P. resinosa*

FF. Leaves not breaking when bent, stout, sharp-pointed.

G. Leaves 1 to 3 inches long.

H. Prostrate shrub or many-stemmed small tree; leaves twisted; cones conic-ovid, lustrous, with pyramidal apophyses; common in northeastern towns. *P. Mugo*

HH. 1-stemmed tree to 60 feet; leaves incurved; cones ovoid, with swollen apophyses; rare. *P. Heldreichii*

GG. Leaves 2½ to 6 inches long.

H. Buds white, not resinous; leaves 2½ to 4 inches long; cones ovoid, 1½ to 3½ inches long; nut brown, persistent for many years but with a weak hold on the branch; trunk usually crooked; moderately common in Philadelphia. *P. Thunbergii*

HH. Buds light brown; leaves 3½ to 6 inches long.

I. Buds resinous; cones lustrous, light brown, quickly deciduous, with swollen apophyses; large erect tree; common in Northeast. *P. nigra* var. *austriaca*

II. Buds slightly resinous; cones not lustrous, dark brown, with wrinkled apophyses; flat-topped or erect tree; uncommon. *P. tabulaeformis*

BB. Terminal buds branched, resinous; spring shoots multinodal; cones tenaciously persistent; trees bearing cones at early ages.

C. Young branchlets covered by a bloom; cones opening when mature, armed with slender prickles; leaves 1½ to 3 inches long; common in New Jersey but uncommon in Philadelphia. *P. virginiana*

CC. Young branchlets without bloom; cones lustrous.

D. Leaves ¾ to 1½ inches long (longer in seedlings); cones unarmed, asymmetrical, frequently remaining unopened for years, 1 to 2 inches long; common in Pennsylvania forest plantings. *P. Banksiana*

DD. Leaves 1 to 3 inches long; cones armed.

E. Cones armed with very stout prickles, symmetrical, light brown; leaves 1 to 3 inches long; branchlets lustrous orange-brown; uncommon in Philadelphia. *P. pungens*

EE. Cones armed with slender prickles; light yellow-brown, asymmetrical; leaves 1 to 2 inches long; rare in Philadelphia. *P. contorta*

AA. Leaves in bundles of 3 (sometimes 2 in *P. ponderosa, P. Elliottii* and *P. echinata;* 3 to 5 in *P. leiophylla* and *P. Engelmannii*).

B. Terminal buds branched; spring shoots multinodal; cones with sharp prickles; uncommon in southeastern Pennsylvania.

C. Leaves 5 to 10 inches long, branches with slight bloom.

D. Leaves 2 or 3 per bundle, dark green; cones dark lustrous brown, 2 to 6 inches long, stalked. *P. Elliottii* var. *Elliottii*

DD. Leaves 3 per bundle, pale green; cones red-brown, 2½ to 4 inches long. *P. Taeda*

CC. Leaves 3 to 7 inches long.

D. Cones conic-oblong, 3 to 6 inches long, tan, reflexed, asymmetrical, lustrous, not opening at maturity and tenaciously persistent; apophyses conical, ending in stout prickles; branchlets dark orange-brown; trunk without tufts of leaves; rare in the East. *P. attenuata*

DD. Cones conic-ovoid, 1½ to 3 inches long, symmetrical, opening at maturity; apophyses keeled but not conical, armed with slender prickles; trunks frequently adorned with tufts of leaves; trees sprout from base if cut when young; crowns of old trees rounded; common in New Jersey but rare in Southeastern Pennsylvania.

E. Leaves slender, 2 or 3 per bundle; young branchlets with a bloom; cones dull brown; has a straighter trunk, finer branches, and lighter bark than *P. rigida.* *P. echinata*

EE. Leaves stout, 3 per bundle; branchlets lustrous chocolate brown; cones lustrous light-brown; commonly with large branches. *P. rigida*

BB. Terminal buds unbranched; spring shoots uninodal.

C. Leaves 3 to 4 per bundle, 2½ to 4½ inches long, leaf sheaths deciduous; cones 1½ to 2½ inches long, stalked, requiring 3 years to develop, persistent, lightly armed; rare in the Northeast. *P. leiophylla* var. *chihuahuana*

CC. Leaf sheaths persistent; cones requiring 2 years to develop.

D. Leaves 8 to 18 inches long, dark-green; buds large, white, not resinous; trees having few branches; rare north of Virginia. *P. palustris*

DD. Leaves 4 to 12 inches long.

E. Branchlets covered by a bloom.

F. Branchlets less than 1/4 inch in diameter; leaves dark green, 4 to 6 inches long; cones 2 to 4 inches long, lustrous, dark brown, without prickles; very rare in the Northeast. *P. yunnanensis*

FF. Branchlets more than 1/4 inch in diameter; leaves blue-green, 4 to 12 inches long; cones 6 to 10 inches long, with sharp prickles.

G. Leaves 4 to 9 inches long; not sparse; cones symmetrical, sessile, 6 to 8 inches long, armed with a slender, recurved prickle, dropping without their basal scales; rare in the Northeast.*P. Jeffreyi*

GG. Leaves pale blue-green, sparse, stout, 8 to 12 inches long; cones massive, stalked, slightly asymmetrical, 6 to 10 inches long, armed with stout, incurved prickles; seeds 3/4 inches long, dark brown, longer than the wings; very rare in the Northeast. *P. Sabiniana*

EE. Branchlets without a bloom, leaves dark green.

F. Leaves 2 or 3 per bundle, 5 to 11 inches long; cones armed 3 to 6 inches long, often dropping without their basal scales, red-brown; taproot of seedlings of same diameter as the stem, the seedling stem elongating each year of growth. *P. ponderosa*

FF. Leaves 3 to 5 per bundle, 5 to 7 inches long; cones 5 to 7 inches long, yellow-brown; seedlings with a thickened taproot and with a stem which elongates very little for several years. *P. Engelmannii*

### Synopsis By Species

Table 2 includes the dimensions of the largest specimen which we have measured of each species now growing in the Philadelphia area. This method of presentation probably gives a truer picture of each species' potentialities than would presentation of the dimensions of the average tree because many of the trees are believed to be of inferior seed origin and others were certainly planted on below-optimum sites. In that table and in the textual comments which follow the species have been grouped by series and by geographic origin, in order that those with the greatest number of characteristics in common can be studied together.

### Series Sylvestres

This is the most useful series for Pennsylvania foresters and horticulturists. It includes the American red Pine, the three most commonly planted European species, and those Asiatic species which are hardy in our area. Nearly all these species are desirable from horticultural standpoint and several seem destined to become important timber trees in Pennsylvania. The potentialities of the group are only partially explored. Recent hybridization studies have shown that many hybrid combinations involving the European and Asiatic members of the series can be made in quantity and that some of these grow much faster than the parent species. Within the next quarter century we shall probably be using a great many of these hybrids as well as the pure species mentioned here.

### Red Pine

(*P. resinosa* Ait.)

Red pine, which derives its common name from the red bark found on older trees, is a tree of our northern forests. It is native from Nova Scotia west to Minnesota and south to West Virginia. It formerly covered large areas and was one of the species on which the original lumber industry of Maine, Michigan, and Wisconsin was based. Most of those original forests have been cut, and few have reproduced themselves satisfactorily. However, the species is in no danger of dying out because hundreds of thousands of acres of forest plantations have been established. This planting program still continues. For example, over 40,000,000 nursery seedlings are produced each year in the state of Michigan.

This species occasionally grows as tall as 150 feet but heights of 70 or 80 feet are much more common. When grown in the forest it is a beautiful tree, with its red bark and straight, branch-free boles. If an incipient fork occurs in a young tree one stem usually grows slightly faster than the other, which then droops to become a branch. Thus, the mature trees are rarely forked.

Red pine was commonly planted around Philadelphia in the 1930's. A great many of these plantings are now suffering greatly from attacks by the European pine shoot moth (*Rhyacionia buoliana* (Schiff.)), and some have been cut down because of their unsightly appearance. This insect feeds on the buds which produce the next year's growth. If, as sometimes happens, every bud on the tree is killed, many twigs die and the tree's growth is considerably retarded. This species is no longer recommended for planting in warm regions except by owners who are prepared to spray their trees each year. Fortu-

nately, this pest seems to be controlled by long periods of low temperatures and the thousands of acres of plantings in cold areas are still relatively free from attack.

Red pine is particular as to the soil on which it grows. It prefers a deep, well-drained soil of moderate fertility, and cannot tolerate soils with a permanently high water table.

Considering the fact that it has a large natural range, this species seems to be very uniform genetically. In seed origin tests which have been conducted in Northern Pennsylvania and in Minnesota the extreme growth rate differences have only been about 10 percent, as compared with differences of 50 percent or more in most species. Red pine also seems to be difficult to hybridize. In spite of years of trials in several different places only one hybrid (with European black pine) has yet been reported.

### Scotch Pine
### (*P. sylvestris* L.)

Scotch pine is the most widely distributed pine species in Europe or Asia. Its natural range extends from Spain to eastern Siberia and from Turkey to north of the Arctic Circle in Scandinavia. In several north European countries it is the only native pine species and forms extensive forests. Its importance as *the* pine in those countries is reflected by the fact that it is called by a single word in several languages. For example, it is *tall* to the Swedes, *Kiefer* to the Germans, *sosna* to the Russians, and *deal* when imported as wood into English-speaking parts of the British Commonwealth.

The great amount of genetic variability within this species has already been mentioned in the section on racial variability. In the New Hamp-

Table 2. Dimensions of the largest tree of each species measured in Philadelphia arboreta.

| Common name | Scientific name, *Pinus*— | Trees measured | Age | Total height | Height growth per year[3] | Diameter breast high | Where seen[4] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Number* | *Years* | *Feet* | *Feet* | *Inches* | | | |
| | | SYLVESTRES | | | | | | | |
| Red | resinosa | 15 | 44 | 47 | 1.5 | 17 | H | M | *W* |
| Scotch | sylvestris | 45 | 50 | 58 | 1.1 | 21 | H | *M* | W |
| Austrian | nigra var. austriaca | 40 | 62 | 65 | 0.8 | 18 | H | M | *W* |
| Mountain | Mugo var. rostrata | 2 | 28 | 23 | 0.8 | 4 | *H* | W | |
| | Mugo var. Mughus | 4 | 26 | 7 | 0.3 | — | *H* | M | W |
| Balkan | Heldreichii | 1 | 21 | 20 | 1.0 | 7 | *H* | | |
| Japanese black | Thunbergii | 23 | 36 | 56 | 2.0 | 13 | H | M | *W* |
| Japanese red | densiflora | 24 | 33 | 46 | 2.3 | 10 | H | M | *W* |
| Chinese | tabulaeformis | 7 | 45 | 25 | 0.6 | 14 | H | *M* | W |
| Masson | Massoniana | 7 | 10 | 10 | 1.0 | 2 | *M* | W | |
| Yunnan | yunnanensis | 1 | 8 | 9 | 2.2 | 2 | *M* | | |
| | | AUSTRALES | | | | | | | |
| Shortleaf | echinata | 5 | 36 | 40 | 1.1 | 13 | H | M | *W* |
| Loblolly | Taeda | 4 | 34 | 50 | 2.5 | 13 | H | M | *W* |
| Longleaf | palustris | 1 | 23 | 33 | 1.3 | 8 | *M* | | |
| Slash | Elliottii var. Elliottii | 1 | 19 | 16 | 0.8 | 2 | *M* | | |
| Ponderosa | ponderosa | 23 | 31 | 32 | 1.0 | 11 | *H* | M | W |
| Jeffrey | Jeffreyi | 5 | 21 | 18 | 0.9 | 7 | *H* | M | W |
| Apache | Engelmannii | 3 | 9 | 13 | 1.8 | 3 | M | *W* | |
| | | INSIGNES | | | | | | | |
| Jack | Banksiana | 7 | 23 | 28 | 1.0 | 10 | H | *M* | |
| Lodgepole | contorta | 3 | 34 | 18 | 0.5 | 6 | M | *W* | |
| Virginia | virginiana | 5 | 23 | 28 | 1.0 | 9 | *H* | M | |
| Pitch | rigida | 25 | 56 | 64 | 1.4 | 17 | H | M | *W* |
| Table-Mountain | pungens | 8 | 44 | 33 | 1.2 | 12 | H | M | *W* |
| Knobcone | attenuata | 1 | 8 | 3 | 0.3 | — | | | |
| Cluster | Pinaster | 12 | 10 | 19 | 2.7 | 5 | *M* | | |
| | | LEIOPHYLLAE | | | | | | | |
| Chihuahua | leiophylla var. chihuahuana | 2 | 14 | 8 | 0.5 | 2 | *W* | | |
| | | MACROCARPAE | | | | | | | |
| Digger | Sabiniana | 2 | 18 | 18 | 1.1 | 8 | M | *W* | |

[3] For the past five years.

[4] H = Haverford College, Haverford, Pa.; M = Morris Arboretum; W = Westtown School, Westtown, Pa. Italics indicate the arboretum in which the largest tree is located.

shire study 11 genetically different entities could be recognized, even though the test included origins from only half of the species range. This variation is evident in nearly all parts of the tree—growth rate (4 to 1 differences), seed size (3½ to 1 differences), cone size, leaf length, winter foliage color, stem straightness (all stems perfectly straight to nearly all stems crooked), and earliness of fruiting. Some of these genetically different races have also been given scientific varietal names and included in standard taxonomic manuals such as Rehder (1940). Perhaps all the races can be so described if the species is ever properly monographed.

This has been one of the most commonly planted conifers in Philadelphia gardens. It is easily recognized by its short, stiff, twisted, and gray-green needles. Trees up to 40 feet tall are common, with occasional specimens reaching 70 feet. (Fig. 15).

In the past decade Scotch pine has become a common Christmas tree in the northern United States. Michigan growers are now planting 30 million trees per year of this one species and Pennsylvania growers are also planting large quantities. In fact the amount planted exceeds the potential Christmas tree cut by such a great amount that Scotch pine will almost certainly be one of our most common timber trees 20 years hence. Growers prefer this species because it is easy to grow, relative free from pests, and can be sheared to produce a regular, full crown. Buyers prefer it (to the extent of paying more per tree for this than for any other common species according to a recent marketing survey in Michigan) because of its short needles, blue-green foliage, and regular crown.

There are no origin data for the older trees planted around the state. We suspect that most of them came from Germany, Poland, or Czechoslovakia. Those are fast-growing, relatively long-needled, and have a tendency to have crooked stems. Occasionally we find trees that appear to be of Latvian provenance; they grow at the rate of 1¼ to 1½ feet per year, have shorter needles and smaller branches, and produce straight trunks. There is a small planting at Haverford College which has grown less than 1 foot per year and has very short needles; it appears to be of Swedish origin. During the past few years this situation has changed markedly and most Christmas tree growers now pay a great deal of attention to the seed they order. Preferred origins are Sierra de Guadarama, Spain; Auvergne, France; Scottish highlands; Belgian lowlands (probably from the vicinity of Hagenau, France originally), the foothills of the Alps around Vienna; and Riga, Latvia. A great deal of the so-called "Riga" seed seems to be wrongly named, having come either from East Prussia or Poland.

### European Black Pine
### (*P. nigra* Arnold)

The European black pine is an introduction from southern Europe, where it grows naturally in the mountains of Spain, Corsica, Italy, Austria, the Balkan Peninsula, the Crimea, and Turkey. It is extremely variable and perhaps should be considered as several different species. Some idea of this variability can be obtained from the fact that over 105 different scientific names have been proposed for all or parts of it one time or another.

In the eastern United States only the Austrian variety (*P. nigra* var. *austriaca* (Hoess) Aschers. & Graebn.) is planted to any extent. This variety is fairly uniform. It has dark green and sharp needles which are about 4 inches long, straight trunks, coarse branches, and a growth rate of 1 to 1½ feet per year. It has been commonly planted in many parts of southeastern Pennsylvania, and trees of all sizes up to 70 feet tall can be found (Fig. 16). In some sections—for example in an old field adjoining St. Thomas Episcopal Church at Whitemarsh—considerable natural reproduction has become established.

In the Morris Arboretum there is a single specimen of the Corsican pine (*P. nigra* var. *Poiretiana* (Ant.) Aschers. & Graebn.). It is now about 30 feet tall and has much smaller branches and a much narrower and more open crown than the common Austrian pine. In Rochester, New York, and Wooster, Ohio are a few specimens of this and other varieties of the European black pine. These show the same diversity of characters that is evident in natural stands in Europe, some growing 1 foot per year and others 2½ feet per year, some having very fine branches and others very coarse branches, some being susceptible to the same pest that is rarely seen on others.

Austrian pine is now being used as a replacement for red pine in the forest planting programs for warmer regions such as southeastern Pennsylvania, New Jersey, and southern Michigan. It grows a little slower and has somewhat coarser branches than the red pine but is greatly superior to that species in resistance to European pine shoot moth and in ability to grow on varied soil types. European results indicate that it will produce about the same type of lumber as red pine.

We have used Austrian pine in our species hybridization program and have obtained two combinations that appear to be exceptionally fast growing and useful under Philadelphia conditions. There are *P. Thunbergii* × *P. nigra*

and *P. nigra* × *P. densiflora*. Natural hybrids of the latter combination occur frequently in progenies raised from open-pollinated seed collected from Austrian pine that is close to flowering Japanese red pine trees.

### Mountain Pine
### (*P. Mugo* Turra.)

The mountain pine is a native of the Pyrenees, the Alps, and the high mountains of the Balkan Peninsula. It is an exceptionally variable species. In the Pyrenees it becomes a medium-sized tree up to 75 feet tall (*P. Mugo* var. *rostrata* (Ant.) Hoopes). In the Alps and Balkans it is only a shrub or small tree (*P. Mugo* var. *Mughus* (Scop.) Zenari and *P. Mugo* var. *rotundata* (Link) Hoopes).

The dwarf, shrubby forms are very common in the Philadelphia area. For the most part people plant trees that are only about 1 foot tall and permit them to grow until they are 3 or 4 feet tall and 5 or 6 feet in diameter. The Morris Arboretum formerly had an old specimen which showed the potentialities of the shrub types when allowed to grow. It was more than 5 feet tall and 15 feet across.

On the Haverford College campus are several examples of the erect forms. They are multiple-stemmed, about 20 feet tall, and about half as broad as tall. Seed collected from those plants produced erect seedlings. In some areas such as southern Michigan the erect forms are much more common than the spreading ones.

### Balkan Pine
### (*P. Heldreichii* Christ.)

Balkan pine is a rare species found in the Balkan Peninsula and southern Italy. It is closely related to the European black pine and is sometimes regarded as a variety of that species. A small tree up to 60 feet tall, it is of relatively little importance in horticulture or forestry.

There is but a single specimen in the Philadelphia area. It is a slow-growing, dark green, dense-crowned tree about 20 feet tall. We still regard our identification of that specimen as tentative, based only on leaf and twig characters, because it has not produced flowers or fruit.

### Japanese Black Pine
### (*P. Thunbergii* Parl.)

Japanese black pine is a native of Korea and of the three southernmost Japanese Islands. Its native range extends from sea level to 3,000 feet above sea level. It is resistant to salt spray and frequently grows along the beach, assuming the bizarre, windswept forms that are typical of Japanese paintings. These bizarre forms can also be induced by pruning and starvation and for that reason this is a favorite tree among Japanese gardeners. Its usefulness is not limited to horticulture, however, for it is one of Japan's most important timber trees. On favorable sites it attains a height of 120 feet and produces straight sawlogs. It is sometimes found in pure stands but is more common in mixture with trees such as Japanese red pine, camphorwood, cherry, *Zelkova*, or some of the oaks.

This species is fast-growing in eastern Pennsylvania. (Fig. 17). Two-year-old nursery stock is from 8 to 12 inches tall, and growth rates of 2 to 2½ feet per year are common for older specimens. Most older trees have crooked or leaning stems. This tendency to lean seems to be associated with permanent damage to the root systems incurred during transplanting. It is not apparent in the nursery or in natural reproduction which springs up around untended trees but is common in planted specimens.

Japanese black pines start to fruit at a very early age, sometimes when only 3 years old. Trees which are 10 or 15 feet tall may bear 500 cones per year. As in most pines the female strobili are borne at the tip of the new growth. In some trees, however, female strobili appear in place of the male strobili at the base of the new growth. On one tree in which this happened one small twig bore 56 cones. The cones were so crowded that they could not grow to full size or open properly but they did contain good seed.

Northeastern tree breeders are particularly interested in this species because of the ease with which it can be crossed with other species. During the early 1950's workers at the Northeastern Forest Experiment Station produced hundreds of hybrids between this and other members of the series SYLVESTRES such as Japanese red, Austrian, Chinese, Yunnan, and Masson pines. These hybrids are now under test at various locations in this region. The *P. Thunbergii* × *P. densiflora* hybrids are especially promising. They can be produced in quantity by relatively easy techniques and grow faster than either parent. The *P. Thunbergii* × *P. nigra* hybrids are also fast-growing but are harder to produce.

(*To be continued.*)

# Weather Sequel: The Winter of 1958-1959

Patricia Allison

One sometimes wonders if all Philadelphia weather is "unusual." In the September issue of The Arboretum Bulletin, a few of the consequences to ornamentals of the drought of 1957, the snow burden of the winter, and the prolonged spring of 1958 were described. The drought killed many plants outright, and weakened many, many more. The abundant snow made up in part for the water deficiency but caused terrible breakage of trees and shrubs, and prevented the application of dormant sprays. The growing season was unusually favorable for fungal pathogens and insects that overwintered in abundance.

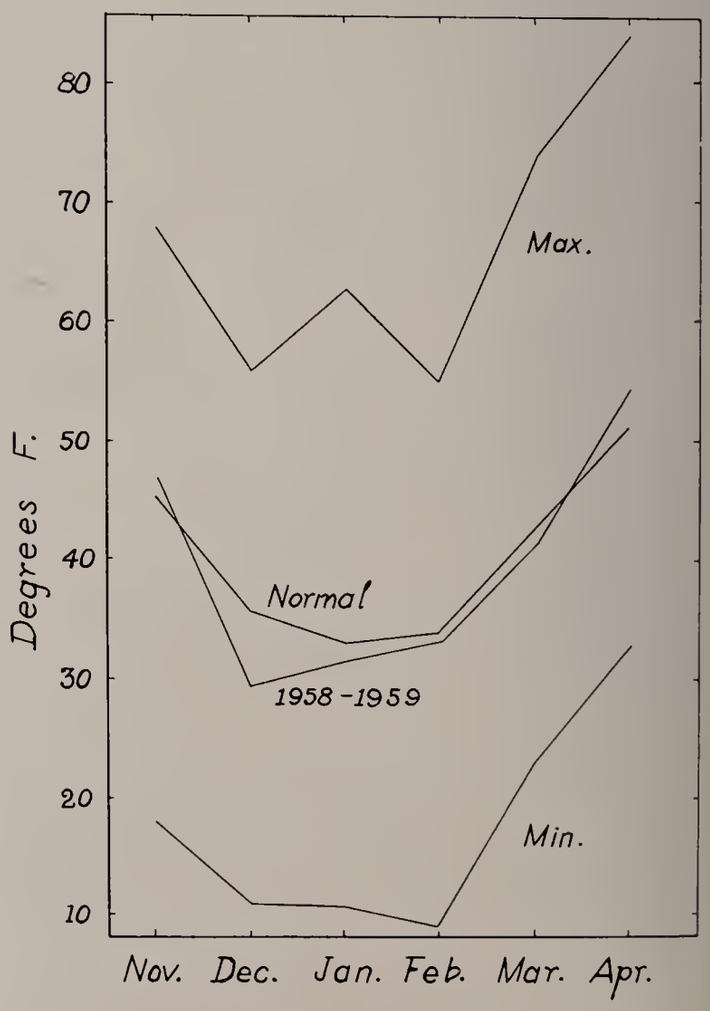
Now we must continue the chronicle, for the winter 1958-1959 was anything but beneficial. It not only prevented recovery from earlier onslaughts, but contributed damage of its own. The winter was cold, yet except for December, with an average temperature 6.5 degrees below normal, it was not exceedingly cold. The winter was dry — exceedingly dry. The winter was bare. Add a sprinkling of contrasting warm days to this winter desert, and the list of offending weather characteristics is complete.

Most of the plant damage was caused by the combination of these four factors that resulted in low soil temperatures and shortage of water at times when loss of moisture from above-ground parts was favored.

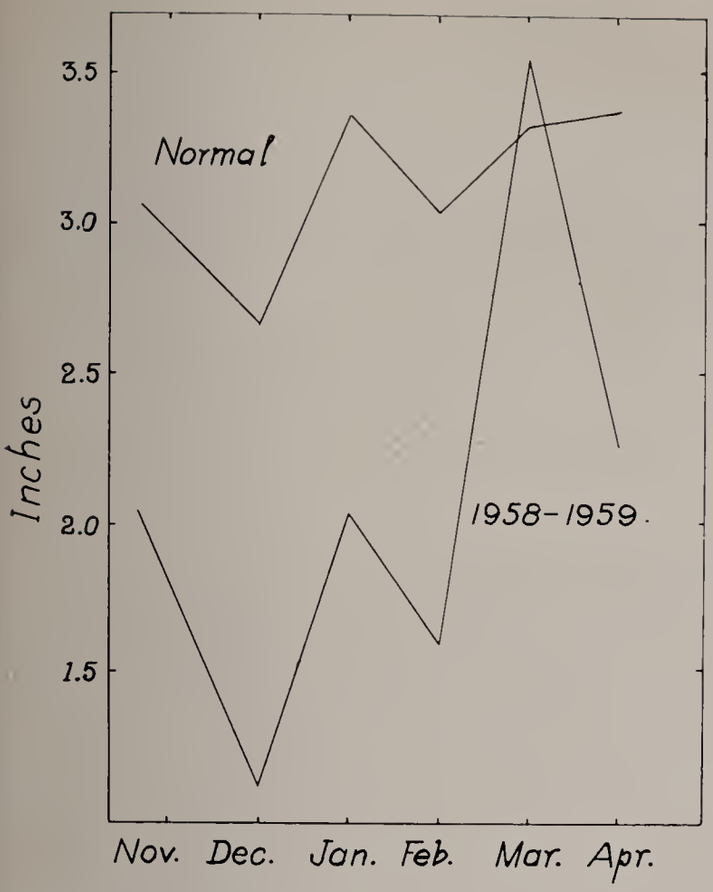
The absence of snow cover was of critical importance. It is known that a relatively mild "weather bureau winter" can be even colder at ground level than a severe "weather bureau winter", since a continuous cover of snow during the latter prevents cooling of the soil. Indeed, differences of 20 degrees are not uncommon between the minimum air temperature and the minimum temperature beneath a snow blanket. Further, it is known that the range between maximum and minimum temperatures is much greater at the soil surface when there is no cover. The total snowfall from November 1 through March was 5.1 inches, the lowest since 1950-1951. Of this, only 0.3 inches were recorded during November and December, and of the 120 days to follow, there were only five for which there is record of more than a trace on the ground. Four of these days were consecutive at the end of January, long after the ground had been cooled in December. (Graph 1.)

What of total precipitation? November was short 1.03 inches; December, 1.54 inches; January, 1.34 inches; February 1.42 inches; April, 1.13 inches. March had 0.23 inches above normal. The total is not encouraging. (Graph 2.) On May 1 we were deficient 6.23 inches of a total normal rainfall of 18.84 inches.

The picture, then, was something like this: The soil cooled early and froze to great depths. At the surface there were extremes of temperature, due not only to normal fluctuations in air temperature, but also to occasional high or low extremes. There was much heaving of the soil as it repeatedly froze and thawed at the surface. Surface vegetation, as ground covers, were damaged directly by freezing, and by root injury caused by heaving of surface oil. In addition, the internal water deficit experienced by larger, deeper rooted plants probably occurred from time to time. This type of internal deficit results




Graph 1. Minimum, Maximum, and Average Monthly Temperatures.




Graph II. Total Monthly Precipitation in Inches of Water.

when root systems are unable to replace water lost from a plant through its above-ground parts. It can happen when low soil temperatures cause slowing in root water-transport processes, when root systems are injured, when freezing of soil moisture makes it unavailable to the plant, and when there is a true shortage of water in the soil. Such internal deficiencies frequently become acute in late winter when there are days warm enough to cause rapid water loss from leaves, but not warm enough to affect either roots or availability of moisture in the soil.

This year, damage was widespread among pachysandra, ivy, and myrtle; and especially severe among evergreens such as holly, azalea, Japanese andromeda, and rhododendron. The injury to ivy and some shrubs was obvious very early, but symptoms of internal water deficiency were spectacular later. As late as April, for example, extensive wilting occurred during the heat wave of the second week when the temperature reached 84.2 on the ninth — a new record. The soil was apparently moist, but more water was leaving the plants than the winter-injured root system supplied. Immediate deep watering saved many plants.

Narrow-leafed evergreens were also hard-hit. Yews and junipers were among those reported most damaged. Injury to large deciduous trees has not been obvious except on dry sites. Trees on such sites that were topped last year may not recover. Of all the reports of winterkill received at the Arboretum, most concerned shrubs transplanted in the spring of 1957.

It is hoped that there will not be immediate additions to our weather story. In the meantime, deep watering is highly recommended.

# Arboretum Activities

*(Continued from page 18)*

## New Plantings

The early advent of freezing weather last November put an end to most of the work of moving plants from the nurseries to their permanent positions. Although somewhat delayed by the tardy arrival of good planting conditions this Spring, considerable progress has since been made in carrying forward our transplanting plans. Chief among these are the following:

Substantial additions to the beds of Glen Dale Azaleas located along the Hillcrest Avenue side of Azalea Meadow.

Filling in of the early-flowering shrub species in the special collection behind the Gates Building.

Supplementary plantings in the special family groupings on the Bloomfield area across Northwestern Avenue.

Preparation of a small bog garden where for the first time we shall be able to grow plants which require acid bog conditions.

Establishment, east of the Baxter Memorial of an area where most of the Heath Family or Ericaceae (exclusive of Rhododendrons and Azaleas) can be displayed.

### Associate Honored

It is with very great pleasure that we report the presentation to Dr. J. J. Willaman of the Superior Service Award of the United States Department of Agriculture. Dr. Willaman is an Associate of the Arboretum and a member of our Advisory Council.

The award, which took the form of a plaque, was made by Secretary of Agriculture Benson at ceremonies held in Washington on Tuesday, May 26. It was given in recognition of Dr. Willaman's distinguished research in plant chemistry conducted at the Eastern Division of the Department of Agriculture at Wyndmoor.

In our Associates' Corner for December 1958 Mrs. Rivinus told something of the work carried on under Dr. Willaman's direction and emphasized the close relationship which has long existed between the Eastern Division and the Morris Arboretum.

J. M. F., Jr.

# Associates' Corner

### Penn's White Oak of Flourtown

Many historical actions took place under outstanding trees. The Magna Charta was signed under an Oak at Runnymeade, Washington took command of the Continental Army under an Elm, Penn's famous treaty with the Indians was also made under an Elm, to mention but a few of them. Boundary lines were recorded as leading to certain trees in old property deeds. Even Pirate's Gold was buried in relation to prominent trees, and many famous spies and highwaymen were hung to such handy gallows. In more recent times, many of us Chestnut Hillers remember the regular directions for the Main Line, "cross the bridge at Conshohocken, turn left and continue to the big tree."

Their, possibly unconscious, esthetic value has made most men love and thrill at the sight of a great tree.

Pennsylvania, named for its wonderful forests, still possesses living trees that were here to greet Penn, but they are almost daily threatened by Bulldozer Progress. Such a one is the White Oak in Flourtown, just one mile north of Chestnut Hill on East Mill Road and some 400 feet off Route 309.

In 1932 the late Edward E. Wildman, collected records of what he called "Penn Trees" and published them in a book that same year, entitled "Penn's Wood." Only trees of at least 250 years of age were eligible. The Evening Bulletin cooperated voluntarily and published articles asking for reports from individuals knowing of such trees which Dr. Wildman incorporated in his book. The chronicle of the Conservation Department of the State Federation of Pennsylvania Women's State's Historic Trees was added. The Conservation Committee of the New Century Club of Philadelphia and the Schools Committee on Penn Memorials also contributed most effectively. Altogether some 700 Penn Trees were recorded as still standing in 1932, among them the Flourtown White Oak. A bronze tablet was placed on that tree in 1932, at which time its circumference was given as 15 feet; it is now over 16 feet.

Such a mighty bulk was bound to catch the eye of the Bulldozer Boys, ever looking for exercise and allergic to anything green on a map. In 1952 the land on which the Oak stands was sold to Flourtown Homes, Inc., and gleefully the Bulldozer Boys oiled their machines.

Fortunately, there were several heritage-minded neighbors who became aware of the proposed vandalism. Spearheaded by Miss Elsa Ueland, Miss Phoebe Crosby and Mrs. John Newbold and under the chairmanship of Mr. T. Morris Perot the Committee for the Preservation of the William Penn Oak was formed and with the invaluable assistance of Commissioner Elmer Perry, the tree was saved, some surgery performed and feeding and spraying applied. This Committee still functions, but the tree needs attention and funds are running low. It is also very necessary to keep this Committee powerful and alert for Bulldozer. Boys are dangerous animals at all times and, when thwarted can be really vicious and resentful. The Preservation Committee is again stirring interest for more members and contributions.

At the meeting of the Advisory Council of the Arboretum Associates held Friday, May 1, 1959, a resolution was passed heartly endorsing the Preservation Committee's actions, a copy of which was sent to Miss Ueland.

As Associates of an Arboretum, which means "a place in which trees are grown," it is most appropriate that we should do all we can to have a magnificent specimen and an irreplaceable part of our heritage in our very midst.

Marion W. Rivinus

# Morris Arboretum Bulletin

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*Pinus Banksiana*

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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# Arboretum Activities

## The Staff

Dr. H. L. Li attended the Ninth International Botanical Congress which was held in Montreal from August 19 to 29.

Dr. Patricia Allison represented the Arboretum at the Annual Meetings of the American Institute of Biological Sciences which took place at Pennsylvania State University, August 30 to September 3.

Miss Mary Milton undertook a week's collecting trip for the Arboretum late in July. She visited the Highland and Durand-Eastman Parks in Rochester, New York, where with the splendid cooperation of Mr. Don Yeager, she was able to assemble a fine series of herbarium specimens, especially of *Tilia* and *Magnolia*, as well as a collection of scions for propagation. She also visited the Cornell Plantations at Ithaca, New York.

Messers John Tonkin, John Dourley and Robert E. Pennewell participated in the Convention of the National Gardeners' Association held at the Warwick Hotel in Philadelphia, August 25 to 27.

## Rose Society Visit

On Friday afternoon, June 12, the Arboretum played host to the American Rose Society which held its 60th Anniversary Meeting in Philadelphia that week. Some 300 members of the Society arrived by bus and were welcomed by a Committee of our Advisory Council under the Chairmanship of Mrs. Frederic Rosengarten.

*(Continued on page 51)*

# Glimpses of Japanese Gardens

Hui-Lin Li

Garden-making in the Far East is essentially an art, a form of art which has no kin in the West. This garden art is close to the landscape paintings of China and Japan, generally considered as the loftiest achievement in Oriental art. The major feature of the Oriental garden is the stone work, which is, physically and spiritually, quite unrelated to the "rockery" of Western gardens. This stone work can, to some extent, be compared with the art of sculpture in the West; yet again, it is really quite different.

The garden art of the Orient has been extensively dealt with in Western literature in recent times. It has, in the past two centuries, exerted considerable influence upon garden-making in Europe and America. Since the end of the last war, its influence on Western landscaping and architecture has been even more profound.

It was therefore with considerable enthusiasm that I welcomed the opportunity to visit some historic gardens in Japan in a recent trip to that country. I have previously visited numerous classical gardens in China, including the many famous ones in Soochow, a city of ancient culture famed for its numerous old gardens, and Peking, where a number of extensive palace gardens as well as private estates are to this day preserved. My acquaintance with Japanese gardens was formerly limited to a few found in Shanghai and on Formosa, all built in recent times. The chance of visiting Japanese gardens in the indigenous state therefore enabled me to gain at first hand fuller appreciation of the garden art of the Orient.



Fig. 21. The Imperial Garden of Shinjiku Palace



Fig. 22. Hamma Detached Palace

## Historic Interest

As one keenly interested in the past, my visit to Japanese gardens was doubly fascinating due to their historic implications. There are so many classic gardens preserved intact in Japan that the evolution of the art can be studied chronologically with actual specimens. There are gardens still to be seen which originated in the Kamakura period (1186-1335 A.D.). Many of the Muromachi period (1335-1573 A.D.) and the succeeding Momoyama period (1573-1603 A.D.) are still extant in Kyoto. Of the later Edo period (1603-1868 A.D.) many additional ones can be found in Kyoto, Tokyo and elsewhere.

It is well known that the gardens of Japan stemmed originally from those of China. There are, nevertheless striking differences between the gardens of these two countries as they exist today. Thanks to Kuck's exhaustive and enlightening study of Japanese gardens,[1] we realize that these differences have arisen in China rather than in Japan. She points out that the art of gardening of Japan, not only in the beginning but right down through the centuries, has reflected that of China. "The naturalistic gardens still found in Japan were also those of China up to the Ming period." Since that time, gardens in China, following the decline of landscape painting, began to develop strong differences. While in China, no pre-Ming gardens seem to have survived, there still remain in Japan many gardens which date from the earlier periods.

[1] Kuck, Loraine E. The Art of Japanese Gardens. John Day, New York, 1940.



Fig. 23. Imperial Palace Garden, Kyoto

Much remains to be done in elucidating the history of Chinese gardens. The first book on garden-making in all countries, Yuan Yi by Chi Ch'eng of the Ming dynasty, was published toward the end of the 16th century and was written in an archaic style. This work is in need of study and analysis and a complete annotated translation into one of the western languages is highly desirable. But from a study of Japanese gardens, the successive development and evolution of the art in the Far East can be studied from a vivid series of existing examples.

## Gardens in Tokyo

My herbarium study at Tokyo University required me to spend most of my time in Japan in the capital city. Claimed as the most populous metropolis in the world, the big sprawling city is a noisy one bustling with activity. There are only a few public gardens and some former palaces which are now used principally as public parks. These gardens, partially or wholly landscaped in the traditional Japanese style, are so full of picknickers that one can no longer enjoy the tranquility and serenity for which Japanese gardens are designed.

The average tourist will probably first land in Tokyo. Even though his time may be limited, and he may not be able to visit Kyoto, there are several landscaped gardens that are worth seeing. The Shinjuku Palace Garden is probably the one most frequently visited. It is especially popular for the double-flowering cherries which open later than the simple forms. The ground is extensive with parts of it landscaped in the traditional Japanese style and other parts laid out in Western design. The Japanese gardens, built around several ponds, are spacious and beautifully decorated with bridges, lanterns and stone work. (Fig. 21) .

Another large garden, similarly of the "stroll garden" type, is the Hamma Detached Palace Garden, located along the River Sumida and the Tokyo Bay. Originally a villa of the Tokugawa Shogun, it is a "stroll garden" dominated by a large tidal pond. Long, many-sectioned wooden bridges connect the islands in the pond. (Fig. 22). From the hills on one side of the pond an extensive view of the garden and the surrounding regions may be had — a characteristic feature of the gardens of the Edo period.

A similar "stroll garden" is Koroku-en, the original estate of the Tokugawa family of Mito. The center of composition is also a large pond, with surrounding hills, trees and other natural features. The garden was built in the early Edo period. Strong Chinese influence is evident in the design. The construction was first started by Tokugawa Mitsukuni, one of the most famous of the Mitos, who took a deep interest in things Chinese and helped Chu Shun Shui (pronounced as Shu Shun Sui in Japanese), the learned refugee scholar from China. The latter fled the Ching invaders toward the end of the Ming dynasty and lived many years until his death under Mitsukuni's patronage.

In Tokyo, as in most other cities in Japan, the observer can enjoy seeing Japanese gardens nearly everywhere. In parks and other gardens, although of no great historic interest, small plots may be landscaped according to the Japanese style. There are also relics of former classical gardens in places like the campus of Tokyo University and the Koishikawa Botanical Garden. Some of the larger hotels or restaurants also have landscaped gardens. Small simple courtyards are to be found everywhere in the enclosures of private dwellings or on temple grounds.

## Gardens in Kyoto

Kyoto, the ancient capital of Japan, in sharp contrast to modernized Tokyo, retains its quaint and time-honored character. There are numerous places of historic interest and everywhere



Fig. 24. Nijo Castle



Fig. 25. Garden of the Silver Pavilion

one can encounter shrines, temples, palaces and gardens. It is a veritable tourists' mecca for both foreign visitors as well as for the native Japanese. Here, in the city as well as its environs, are found the best of all Japanese gardens.

Generally speaking there are two main types of Japanese gardens: The hill gardens and the flat gardens. The hill gardens feature one or several hills in combination with a pond and a stream. This type of garden requires a larger area, with numerous kinds of trees and shrubs planted to give the varied effects according to the season. The pond may be simple or divided into several parts and it may or may not contain one or more islets. There is often a path winding through the garden, hence the name "stroll garden."

The flat gardens are laid out on a level piece of ground. The ground usually symbolizes the surface of the water, with stones, trees or other decorations to complete the composition. This type of garden is adopted when space is at a premium. The aim of the composition is to give the feeling of spaciousness within a limited and confined area.

Both hill or flat gardens may be simple or elaborate in design. There are endless kinds of variations and all degrees of intermediates between the extremely simple and elaborate ones. The large gardens, either attached to palaces or temples, are all hill gardens. In many Buddhist temples there are also small flat gardens in walled courtyards. Many famous gardens were built by aristocratic priests of past ages. These gardens, more so than others, are designed to be places of contemplation and of spiritual communion with Nature. It was in the hands of the Zen Buddhists that the garden art was brought to its perfection. Many gardens, or certain features of the garden, also bore symbolic meanings related to Buddhism or other ancient concepts.

One type of flat garden is the tea garden, which is usually attached to a tea-house. This type of garden, usually of small size, combines beauty with utility, as it always requires certain necessary features such as entrance gate, path, steps, water-basin, stone lanterns, etc., each to be properly placed. However, as in other gardens the ultimate guiding principle is still one of elegant simplicity.

## Palace Gardens

In describing Kyoto's gardens, although not in their chronological order, one may begin with the larger palace gardens. The garden of the Imperial Palace was reconstructed after a fire about one hundred years ago. It is dominated by a large pond. A large area between the pond and the main building is covered by white sand. The garden on the whole is elegant and dignified in its appearance. (Fig. 23).

Katsura Detached Palace, in the outskirts of Kyoto, was built some 330 years ago by the famous master of tea ceremony and garden art, Enshu Kobori. The grounds are very extensive. The most famous sight is the tea house and the stone path amid the pine trees leading to it. On one side of the path is Ama-nohashidate, a miniature copy of the famous sand beach by this name on the coast of the Japan Sea. The tea house, called Shokin-tei, meaning Pine-lute Pavilion, is so named because of the whistling sound made by the wind in the surrounding pine trees.

The garden of Shugaku-in Detached Palace also occupies a very large area on the hillside and consists of three sections at different levels connected by walks lined with low pine trees. The garden was built for Emperor Gomizunoo from about 1655 to 1659. It is carefully and beautifully designed to blend with the natural scenery in the background.

The Nijo Castle, built in the early half of the 17th century, is a grandiose structure surrounded by a wall with landscaped grounds. (Fig. 24).



Fig. 26. Garden of the Moss Temple



Fig. 27. Stone Garden of Ryoanji

The interior of the main building, with many colorful paintings and murals on the walls and the sliding panels, is most interesting. The garden is also of the "stroll" type, with winding paths around the main pond. There are three small islets in the pond with distinctive and imposing rock work surrounding the pond, suggestive of aggressiveness and powerfulness and in harmony with the castle architecture.

### Golden and Silver Pavilions

Two famous gardens, each dominated by a building, are commonly known as the Golden and Silver Pavilions. The garden of Kinkakuji, Temple of Golden Pavilion, the popular name of Rokuonji, was built in 1397 as a villa by Yoshimitsu, the third Ashikago Shogun. The golden colored pavilion, situated by the edge of the large pond, is a gorgeous wooden structure of three stories, and forms the focal point of the garden. It is also the best point from which to view the entire garden. The original building was destroyed by fire in 1950, and the present structure in an exact replica constructed on the same spot in 1955. The shining building, together with the open area of water and trees give brightness to the whole scenery. The reflection of the pavilion in the pond makes a very beautiful sight.

The garden of Ginkakuji, Temple of Silver Pavilion, was built in 1482 by Yoshimasa, the eighth generation Ashikaga Shogun, as a villa, following the example of the Golden Pavilion. The garden design was patterned after the Saihoji garden now generally known as the Moss Temple. The villa was later converted into a Buddhist temple. Its main feature is the Silver Pavilion, a two storied grayish building formerly coated with silver foil. Besides the pond, hills, and stone works, two famous features are a flat area of white sand and a platform designed especially for moon-viewing. The garden is typical of the Higashiyama epoch (1481-1485), a period in which the tea ceremonial originated. (Fig. 25).

### The Moss Temple

The so-called Moss Temple garden, after which the garden of the Silver Pavilion is patterned, is one of the mast famous and oldest gardens in Japan. It had a very early beginning and was completely rebuilt by the famous Zen Abbott Muso Kokushi, in the style of the earlier Kamakura period (late 12th to 14th centuries). The ground of the entire garden is covered with various kinds of mosses, hence the name Kokedera or Moss Temple, as it is popularly known.

The whole garden is the finest expression of the beauty of curves and contours. The ponds, in the shape of the Chinese character Hsin "Heart", are separated by peninsulas, islands, or mere rocks, and connected by bridges, walks and steps, where a visitor can stroll around. There is also an upper part of the garden higher up on a mountain slope which is composed of dry stone work.

The whole garden is thickly carpeted with mosses, which give a distinctly pleasant feeling of languidness with their soft velvety yellowish green. The view of this garden with sunlight filtering through the trees onto the mossy green floor is a memorable sight. (Fig. 26).

Incidentally, it seems that nobody knows exactly how many kinds of mosses are grown there. The number given in various guide books differs from 20 to 200. The guide map says that there are over 100 kinds, and that they are at their best from May to June. On the entrance thicket, the number is given as about 120.

### The Stone Garden

Another world famous garden is the Stone Garden of Ryoanji. The temple Ryoanji is situated along the foot of scenic Mount Kinugasa, and was founded in 1450. Inside the main gate of the compound is a large pond, with two islets, bridges, scattered stones, and other features. After entering into the temple buildings, one beholds



Fig. 28. Garden of Daitokuji



Fig. 29. Courtyard garden of Nanzenji

in a rectangular courtyard in front of the priest's chamber, the renowned Stone Garden. The yard is enclosed by low dark walls made of oil and mud. The ground is completely flat, with carefully raked fine white gravel spreading over the whole area to signify the surface of a calm sea. There are no trees or plants other than patches of mosses surrounding five groups of stones signifying the five sacred mountains of China or the five sacred cathedrals of the Zen Sect of Buddhism. (Fig. 27).

The five groups of stones are composed, from east to west, of 5, 2, 3, 2, and 3 pieces respectively. They suggest cliff islands. Two of the stones are said to resemble a mother tiger leading her cub swimming. The garden is the ultimate of symbolism in stone gardens. And yet, it is also a masterpiece of art creation as the arrangement of the stones is so well-balanced that no slightest alteration is possible. It is surprising that this artificial beauty can give to the viewer such a feeling of calm and serenity, as attested by the many visitors sitting quietly on the porch. The garden is the best example of the "dry landscape" type, perfected in the Momoyama period out of tea ceremonies and contemplative Zen Buddhism.

### Some Famous Level Gardens

The Stone Garden and other courtyard gardens are small gardens in a walled-in area designed mainly for viewing from the porch of adjoining buildings and not for strolling. The garden of Daitokuji is a small flat courtyard garden typical of the Zen temple gardens of the Muromachi period. Fine white gravel covers the entire ground and a few stones and some trees are placed toward one corner along the wall further from the building. A pair of white stones in the corner simulates a waterfall. Viewed from one end of the porch, one can see the entire garden as well as the distant mountains which merge together completely. (Fig. 28).

Another classical level garden, said to be the model of dry garden of Zen Buddhists, is the courtyard garden of Nanzenji temple. The garden was built in the Edo period. The ground is also covered with fine white gravel and huge boulders are laid with trees close to the wall. The arrangement here is even more simple and more pleasing. (Fig. 29).

In another part of the compound of the Nanzenji monastery is the garden of Konchi-in, an elaborate dry level garden laid out between a grove of trees and a flat area of white sand in front of a building. The rock work simulates a series of islands rising above the surface of the sea. It is known as the garden of crane and tortoise because two of the rocks suggest the islands of tsuru (crane) and kame (tortoise).

### Other Notable Hill Gardens

The garden of Nishi-Honganji is dominated by a large pond with elaborate stone work toward one end. (Fig. 30). In the same temple, there is also a courtyard garden, Kokei, with complicated massive stone work and bridges. Kokei, meaning Tiger Glen, is a name derived from Chinese literature, a locality in the Lushan Mountain.

The garden of Samboin, located on the grounds of Daigoji temple east of Kyoto, was started in 1598 by the famous hero-dictator Hideyoshi. The design is very elaborate, with many ponds and hills, adorned with islets and bridges. The stone work is considered the most magnificent of the Momoyama period. It is said that over 700 rocks and several thousand trees, assembled from all over the country were used. The whole garden is designed to be viewed from the several continuous buildings adjoining, unfolding in front of the viewer as he proceeds, like a traditional painting of hand scroll. (Fig. 31).

The garden of Tenryuji, built in the Kamakura period, is the leading garden of the Zen



Fig. 30. Garden of Nishi-Honganji



Fig. 31. Garden of Samboin



Fig. 32. Garden of Chishaku-in

style. The garden is dominated by a pond in the center, with scattered stones in the pond and a waterfall and stone bridge, in a pattern more or less characteristic of the period. The design is under strong influence of the bold landscape of Sung and Yuan dynasties. It is supposed to have been built by the famous Abbott Muso Kokushi some 600 years ago, who was also credited with building the garden of the Moss Temple.

The garden of Chishaku-in is made up mainly by an elongated pond along the base of the mountain Higashiyama. Stone work surrounds the pond and extends up hill to some heights, more or less densely intermixed with plantings of trees and shrubs. There are also bridges of simple artistic shapes. The garden is chiefly designed to be viewed from different parts of the adjoining buildings. (Fig. 32).

### In Retrospect

After seeing the historic gardens of Japan, I am inclined to agree with the thesis made by Kuck, that the gardens of China and Japan, up to the Ming dynasty, were essentially similar and that their present differences have been brought about in China since that time. One can vividly sense, from the classical Japanese gardens, their closeness to landscape painting of Sung and Yuan China. The marked characteristic of both is the simplicity in their design, which is balanced, harmonious and yet elegant.

Toward the end of Yuan and the beginning of the Ming dynasties, Chinese landscape painting went into a gradual decline. The painters made a point of copying and imitating past masters, and no longer sought inspiration from nature. The paintings became conventionalized and pedantic, lacking the vitality and originality of the earlier masters. Following this trend, gardening also degenerated, becoming increasingly cluttered and over-elaborated.

It is thus refreshing to see the classical gardens of Japan, as one would expect to see Chinese gardens at their best in earlier ages. Much of the scenery in these gardens reminds one of a simple, bold sketch of a few stones and bamboos or pines by such Yuan masters as Ni Tsan or Wang Meng. From these Japanese gardens, it is clear that as an art form, they are closely akin to Oriental landscape painting. Both are aimed at recreating a suggestion of nature. To make a garden is to create a serious work of art, a work that is esthetically satisfying to both the creator and the viewer.

# Hard Pines Cultivated in the Philadephia Area

Jonathan W. Wright and Frank S. Santamour, Jr.

(*Continued from page 29*)

### Japanese Red Pine
### (*P. densiflora* Sieb. & Zucc.)

Japanese red pine is native in the principal Japanese islands, Korea, Manchuria, and southeastern Siberia. Most of the natural forests occur between 300 and 3,000 feet in elevation. However, it occasionally grows near sea level or as high as 7,000 feet. Unlike the Japanese black pine it is not resistant to salt spray and is not found close to the shore.

In its native habitat this species grows in pure stands. Or it may be found in mixed stands similar in general appearance to some of our Pennsylvania forests. Its common associates include Japanese black pine, Japanese silver fir, the two Japanese cypresses, alder, cherry, oak, chestnut, magnolia, ash, and *Zelkova*. It is the most massive of Japanese conifers, growing to a height of 120 feet and to a diameter of 7 feet.

Most Philadelphia arboreta contain specimens of Japanese red pine. It is also seen occasionally in private gardens. At a distance it is frequently mistaken for Scotch pine because of the similarity in bark color. However, the two species can easily be distinguished because Japanese red pine has longer, finer, and greener needles.

Most older specimens in this area have crooked stems and flattopped crowns. As in the Japanese black pine, this poor form is believed to be associated with transplanting damage. Natural reproduction surrounding planted trees is usually straight-stemmed and fine-branched. Several years ago we obtained permission to transplant a few natural seedlings from Andorra Nursery to the Morris Arboretum. The ones which we moved are still more or less shrubby. The ones which we left continued to grow at the rate of 2 to 2½ feet per year and (before they were destroyed for a housing development) were over 20 feet tall, had single, straight stems, and had branches less than ½ inch in diameter.

The Japanese umbrella pine (*P. densiflora* var. *umbraculifera* Mayr) is a slow-growing, much-branched cultivar which is admired because of its picturesque trunk form and umbrella-shaped crown. The oldest specimens in the city are in the Morris Arboretum's Japanese Garden I and are responsible for much of the charm of that garden. This cultivar is usually propagated by grafting but can be grown from seed collected from a group of the umbrella-shaped trees which inter-pollinate each other. (Fig. 18).

In the late 1930's Dr. E. J. Schreiner of the Northeastern Forest Experiment Station produced the first hybrids between Japanese red and Scotch pines. These have grown very rapidly in their permanent test locations in northern Pennsylvania and Maryland. They also coned at an early age and produced promising $F_2$ and backcross progeny which are now under test near Philadelphia. Japanese red pine is also a promising parent in combination with other members of the SYLVESTRES.

### Chinese Pine
### (*P. tabulaeformis* Carr.)

Chinese pine is a wide-ranging species native in the mountains of western China. This species is variable and may ultimately be found to contain as much genetic diversity as Scotch or ponderosa pine. It has not been the subject of a thorough seed origin study but trees from the southern part of the natural range are supposed to grow faster and straighter than trees from farther north.

The three old Chinese pines growing in the Morris Arboretum are similar to each other and appear to have been grown from a single seedlot. Each has a flat, table-topped crown justifying the specific epithet *tabulaeformis*. (Fig. 19). In fact the crowns are so flat that we used to sit *on* rather than *in* the tree tops when performing pollinations.

The two specimens in the arboretum of Westtown School are very different from each other and from the Morris Arboretum trees. Each has a single, straight stem and continues to grow upward at the rate of nearly 2 feet per year. One has yellow male catkins and fine needles; the other has red male catkins and coarse needles.

This species hybridizes readily with Japanese black pine but the hybrids have relatively little promise. Even those tree × tree combinations involving the Westtown parents grew slightly slower than pure *P. Thunbergii*.

### Masson Pine

(*P. Massoniana* Lamb.)

This is a native of southeastern China. In spite of the fact that it has an extensive natural range and is an important timber tree in its native country it is little known to western botanists. Judging from the climatic conditions prevailing within its native habitat Masson pine should not be hardy within our area. For that reason we reserve judgment as to the authenticity of the specimens now growing in the Morris Arboretum. (Fig. 20). They certainly have some *P. Massoniana* characters and germplasm but may be natural hybrids with some other species growing in the same oriental botanic garden from which the seed was received. They are similar in several respects to Japanese red pine but differ from that species in having longer and yellower needles and a denser crown.

### Yunnan Pine

(*P. yunnanensis* Franchet)

This is the only 3-needled member of the SYLVESTRES. It is a native of Yunnan and other warm parts of western China. The single Morris Arboretum specimen was grown from seed obtained from a botanical garden, and may possibly be a hybrid.

Several years ago we obtained pollen of pure *P. yunnanensis* from the Institute of Forest Genetics in Placerville, California. With this pollen we produced a number of *P. Thunbergii* × *P. yunnanensis* hybrids. These were easily distinguishable from non-hybrids by exceptionally rapid growth, three needles per bundle, and needle length (longer than in pure *P. Thunbergii*). Several of these hybrids are under test in the Morris Arboretum, in the grounds of the Flower Observatory near Paoli, and in Washington Crossing State Park, New Jersey.

### Series Australes

AUSTRALES is a New World series composed of five southeastern and nine or more western and Mexican species. It might be considered as two separate series. The southeastern species have similar ranges, are primarily multinodal, produce relatively dense wood, and cross easily with each other but not with the western species. On the other hand most of the western members of the series are uninodal and produce relatively soft wood.

Philadelphia is near the northern extremity of the range of the eastern AUSTRALES. We can expect to make relatively large use of the two hardiest species — shortleaf and loblolly pines — but probably will never grow the less hardy ones except as curiosities.

The western United States members of the series which have been tested here appear to have considerable promise. They have been hardy, have grown moderately rapidly, and have had as good timber form as some of our native species. Their full potentialities can only be guessed at. Future plantings will contain better seed origins than have been used in the past. They may also contain some of the species hybrids which have grown so well in California trials.

### Shortleaf Pine

(*P. echinata* Mill.)

The natural range of shortleaf pine extends from Long Island and southern Pennsylvania south to northern Florida, and west to southwestern Illinois, Missouri, and eastern Texas. In large parts of this range it forms extensive forests and is an important timber and pulpwood species. It is a very important component of New Jersey's pine forests.

At present this species is considered as belonging to the series AUSTRALES. Perhaps it might better be grouped with the pitch pine for the two hybridize easily and are similar in many respects. For example, both sprout from the base when cut and bear leafy twigs along the trunk (these characteristics are more pronounced in pitch than in shortleaf pine). The shortleaf



Fig. 33. Longleaf pine, *Pinus palustris*

pine generally has a straighter trunk and finer branches than does the pitch pine.

The few trees of this species in Philadelphia have been planted in arboreta. They are relatively slow-growing and open-crowned, and are without particular horticultural merit.

### Loblolly Pine

(*P. Taeda* L.)

This is a native of the Coastal Plain and Piedmont from Cape May, New Jersey south to central Florida and west to eastern Texas. Its natural range also extends northward along the Mississippi Valley to Arkansas and Tennessee. Because of its rapid growth and good form it is an important timber tree in most of its range. Forest plantings in central New Jersey indicate that its commercial range may be extended into this area for in these plantings it grew faster and has smaller branches than the native species.

The few loblolly pines planted in Philadelphia arboreta are very fast-growing and have relatively long needles, fine branches and narrow crowns. This species should find considerable horticultural use in situations where large, straight evergreens with moderately dense foliage are desired.

Loblolly pine seedlings grow much faster than do seedlings of northern conifers. At the end of their first year they are frequently 8 or 10 inches tall and by the end of their second year they may be 2 or 3 feet tall. Because of this rapid growth they should be placed in their permanent locations at the start of the second growing season.

### Longleaf Pine

(*P. palustris Mill.*)

Longleaf pine, so named because its needles are sometimes 18 inches long, is a native tree of the Coastal Plain from southeastern Virginia to Texas. Almost everywhere within its range it is an important tree, producing large quantities of lumber, pulpwood, resin, and turpentine. The fleshy roots of its seedlings also furnish hog food but this is a feature that foresters do not appreciate.

The single Morris Arboretum specimen (perhaps the only one north of Virginia) has been unexpectedly hardy. In some winters it has suffered a little leaf-browning but each spring it has promptly recovered. It has produced very few side branches and has grown more slowly than it would have in the South but is nevertheless easily recognizable by anyone acquainted with the species. (Fig. 33).

The seedling growth pattern is different from that in any northern species. Under natural conditions the seedling may make negligible height growth for a long period and may remain in this "grass" stage up to 15 years. Prescribed burning and removal of competing vegetation may sometimes induce normal height growth.



Fig. 34. Ponderosa pine, *Pinus ponderosa*

### Slash Pine

(*P. Elliottii* Engelm. var. *Elliottii*)

The natural range of slash pine is confined to the Coastal Plain from southeastern South Carolina to eastern Louisiana. In central and southern Florida it is replaced by the South Florida slash pine, *P. Elliottii* var. *densa* Little & Dorman. It is the fastest growing of all the southern pines and for that reason is planted extensively within its natural range. It is also being planted in large numbers in Queensland and other moist parts of the southern hemisphere.

The single specimen at the Morris Arboretum has done well to remain alive for 19 years under adverse shading conditions. It has certainly not shown any of the rapidity of growth for which it is so well known.

### Ponderosa Pine

(*P. ponderosa* Laws.)

The principal area of distribution of this species is in the Rocky, Cascade, and Sierra Nevada Mountains from Canada to northern Mexico, but there are outlying populations as

far east as the Dakotas and Nebraska. Over large areas of this range it forms extensive pure stands which contain little or no undergrowth and look like well-kept parks. This is the largest of the hard pines, attaining a maximum height of 230 feet and a maximum diameter of 8 feet.

Ponderosa pine is a variable species. Three geographic varieties — *P. ponderosa* var. *arizonica* (Engelm.) Shaw of southern Arizona and New Mexico, *P. ponderosa* var. *scopulorum* Engelm. of Utah, eastern Nevada, and western Colorado; and *P. ponderosa* var. *ponderosa* — are commonly recognized. In addition there are several races which have not been given Latin names. We do not have origin data for any Philadelphia trees, so cannot say whether they are the best available in the species. (Fig. 34).

The tallest ponderosa pines within the Philadelphia area are found on the campus of Haverford College. They are healthy and full-crowned and have grown about 1 foot in height per year. They are similar to Austrian pine in general appearance but are distinguishable from that species by their longer needles and armed cones.

Although ponderosa pine is a native of dry sites in the West some of the thriftiest specimens in the Philadelphia area are growing on very poorly drained soils near Center Square. They were planted there about 10 years ago and have exhibited no signs of poor growth due to inadequate soil aeration.

### Jeffrey Pine
### (*P. Jeffreyi* Grev. & Balf.)

Jeffrey pine is a native of the Sierra Nevada and a few other high mountain ranges from southern Oregon to northern Baja California. It typically grows at higher elevations than does the ponderosa pine. Like that species, it attains large sizes (up to 200 feet tall) and usually grows in open stands with little underbrush.

This species is similar to ponderosa pine in general appearance and has been treated as a variety or mere ecological variant of the latter in some manuals. However, recent work at the Institute of Forest Genetics in Placerville, California has shown that the two are without a doubt distinct enough to be considered as separate species. In fact that work showed that the Jeffrey and Coulter pines are more closely related than are Jeffrey and ponderosa. Not only do the Jeffrey and Coulter pines cross readily but they contain a substance, heptane (an ingredient of gasoline) not found in any other hard pines (Mirov, 1946).

The few Jeffrey pines found in Philadelphia are healthy, but are open-crowned and slow-growing. Certainly they are far different in appearance from native trees or from plantings in southern Michigan and southern Illinois. In the latter two places this species has attained heights of about 50 feet and appears capable of becoming an important timber tree.



Fig. 35. Apache pine, *Pinus Engelmannii*

### Apache Pine
### (*P. Engelmannii* Carr.)

The Apache pine is a little known species from the high mountains of southern Arizona and New Mexico and from northern Mexico. It has been considered by many to be merely a geographic variety of ponderosa pine, which it resembles in most respects. However, it merits recognition as a separate species, if for no other reason than the fact that its seedlings pass through a fleshy-rooted "grass" stage in which there is little leader elongation for several years. That stage is not present in ponderosa pine. (Fig. 35).

The circumstances surrounding this species' introduction into the Philadelphia area are almost unbelievable to any one accustomed to planting trees in the spring. Mr. A. L. Baily, Jr., who was then in charge of the arboretum at Westtown School vacationed in Arizona in August. While there he dug wildlings and shipped them — barerooted — to Philadelphia by express. They were promptly planted upon arrival and have thrived ever since. One is now growing at the rate of 1.8 feet per year.

### Series Insignes

The series INSIGNES is a catch-all including species of widely diverse origins and habits of growth. Of most interest to us in Philadelphia is a group of six species from eastern and northern United States. These are the familiar jack, Virginia, pitch, pond, Table-Mountain, and lodgepole pines. They are all rather limby trees that develop wide, spreading crowns and produce knotty lumber unless they are carefully tended. However, they are of great importance within the region if not within the city because (with the exception of pond pine) they are capable of growing on dry, sterile soils for which better species are not adapted. The sand pine of the Gulf Coast is a seventh member of this group, but is probably not hardy within our area.

The California closed-cone pines (Monterey, knobcone, bishop, and Santa Cruz Island, *P. remorata* Mason) form another natural group within the series. These are of great theoretical interest because their evolutionary history is well known and because one of them (Monterey pine) has been planted on hundreds of thousands of acres in the southern hemisphere. However, except for knobcone pine which has survived here for several years, these California species will probably not prove hardy.

Thirdly there is a group of four species from warm-temperate or sub-tropical parts of Mexico. Like the California closed-cone pines, these Mexican trees are probably only of academic importance to Pennsylvanians.

Last is a group of two south European species. One of them, cluster pine, has proved unexpectedly hardy and will probably be a valuable ornamental or forest tree. The other, Aleppo pine, has been tested in Philadelphia but died the first winter.

### Jack Pine
### (*P. Banksiana* Lamb.)

Although a comparative stranger in the Philadelphia area this is one of the most common eastern American pines. Its natural range extends from New Brunswick south to northern Pennsylvania, west to Minnesota, and northward across Canada nearly to Alaska. It is typically a small, branchy tree growing only 50 or 60 feet tall and 1 to 2 feet in diameter. However, it can have good timber form if it is severely crowded. In spite of its deficiencies it is a very important timber and pulpwood tree in the northeastern United States and Canada because it occupies hundreds of thousands of acres of dry, sterile soils on which other trees do not thrive.

Most jack pines within Philadelphia are found in arboreta. They are broad-crowned and have large branches. Their foliage is usually rather sparse and they are without particular horticultural merit. (Fig. 36).

Limited numbers of young jack pine are marketed at Christmas time as "Bank pine" or "golden Banks pine". Even with those fancy names they have not made much of an inroad on the Christmas tree market because their crowns are not as full as most people desire.

### Lodgepole Pine
### (*P. contorta* Loud.)

This is the western counterpart of the jack pine. Like the latter species it can grow well on rather poor soils, holds its unopened cones until they are opened by heat, and comes in extensively after forest fires. It is a wide-ranging and variable species consisting of four easily recognizable subspecies: ssp. *latifolia* of the American and Canadian Rockies; ssp. *murrayana* of the Sierra Nevada and Cascade Mountains from California to British Columbia; ssp. *contorta* of the coastal mountains from California to Alaska; and ssp. *bolanderi* of the plains back of Cape Mendocino in California. Those subspecies vary considerably in such characteristics as needle and cone shape, growth rate, growth form, and hardiness.



Fig. 36. Jack, *Pinus Banksiana*



Fig. 37. Lodgepole pine, *Pinus contorta*

Under natural conditions lodgepole pine sometimes forms stands so dense that a man can hardly walk between the trees. The trees in such stands are spindly, 20 or 30 feet tall and only a few inches in diameter. The Indians thought them ideal for supporting tepees — hence the common name.

Lodgepole pine has been grown only as a curiosity in a few Philadelphia arboreta. The trees are thrifty in appearance but slow-growing, open-crowned, and large-branched. A great deal of this poor performance may be due to improper seed origin because there are nice-looking stands elsewhere in the East. (Fig. 37).

The lodgepole and jack pines cross readily and there is a considerable area in western Alberta in which the forest consists almost entirely of hybrids. We produced some of these hybrids in Philadelphia and found them to be intermediate between their parents in most characters.

### Virginia Pine
### (*P. virginiana* Mill.)

Virginia pine is a native of the eastern United States. Its natural range extends from New York south to Georgia and west to southern Indiana. It is common in New Jersey and Maryland and is occasionally seen on dry ridges along the Pennsylvania Turnpike. It can grow as tall as 90 feet but in most places reaches heights of only 50 or 60 feet. Like jack and lodgepole pines it is very branchy when open-grown but produces straight-stemmed trees if grown in a dense stand. It is valuable chiefly because of its ability to grow on poor soils, and is principally used for pulpwood.

The few Philadelphia-area trees are typical of many open-grown specimens seen in the New Jersey pine barrens. They have broad crowns, large branches, short needles, and are grown chiefly as curiosities. (Fig. 38).

### Table-Mountain Pine
### (*P. pungens* Lamb.)

Table-Mountain pine derives its common name from Table Mountain, Georgia, on which it occurs. However, it could equally well be named for its table-topped appearance because it is almost always a short, broad-crowned tree. It grows on very dry soils from New Jersey to Georgia and Tennessee but is nowhere common.

In the Philadelphia area we have seen it planted only in the three arboreta mentioned in Table 2. In all cases it has had thrifty, dark-green needles 2 to 3 inches long and a picturesque, open crown. It would form an interesting oddity in medium-sized gardens where spreading evergreens 20 to 30 feet tall were desired.

The cones of Table-Mountain pine are distinctive. They are ovoid, light brown, 2 to 3 inches long, tenaciously persistent for years after maturity, and armed with such stout spines that gloves or clippers are necessities for seed gatherers. But it is the cone arrangement which is most interesting. Even on old trees the ability to bear fruit is shared by only a few large branches and year after year the female strobili appear only at the tips of branches on which cones were borne for the previous 10 or 15 years.

### Pitch Pine
### (*P. rigida* Mill.)

This is an inhabitant of dry ridges and gravelly soils from Mt. Desert Island in Maine south to Maryland in the Coastal Plain and south to northern Georgia in the Appalachians. It is one of the most common timber species in New Jersey.

This species is included with the INSIGNES because it has persistent cones. However, it does not cross with other members of the group and probably should be considered as more closely related to shortleaf and other southeastern pines. (Fig. 39).

The largest pitch pines in the Philadelphia area were recently cut for a housing development. They were located on an old farmstead near Center Square. The three veterans were between 60 and 70 feet tall and between 2 and 3

feet in diameter. They were rather coarse-branched and had crooked boles. Surrounding them to a distance of a few hundred feet was a group of natural seedlings up to 25 feet tall which were growing vigorously and bearing occasional cones. These youngsters had moderately dense crowns and were irregularly branched. They were valuable as curiosities but did not prompt people in the vicinity to plant more pitch pine for landscape purposes.

### Knobcone and Monterey Pines

(*P. attenuata* Lemm. and *P. radiata* D. Don)

Knobcone pine is the most widespread and hardiest member of the West Coast closed-cone pine group. Its total natural range is about 1,000 miles long, and includes several scattered stands in southern Oregon and California. In its natural habitat it is a fast growing but limby tree that attains heights of only 20 or 30 feet (occasionally 100 feet). It is of little commercial importance.

Monterey pine has six small natural distribution areas scattered over a distance of about 600 miles along the coast of southern California and the islands of the California and Baja California coasts. The largest of these natural stands is only a few miles across and the smallest — on Guadelupe Island — consists of only a few hundred trees. In California it is regarded as a curiosity. However, it is of great commercial importance in the southern hemisphere, where over a million acres have been planted. In New Zealand it has grown 160 feet tall in 40 years. And the average per-acre yield from all 20- to 30-year-old stands cut in New South Wales during the period from 1950 to 1955 was 300 times as large as the present annual *per capita* lumber consumption in the United States.



Fig. 38. Virginia pine, *Pinus virginiana*

Several years ago we were intrigued by the rapid growth of these two species and tried a few seedlings of each as well as of the hybrid between the two. They did grow rapidly — 2 to 3 feet the first year — but only one knobcone pine has survived the rigors of Philadelphia winters.

### Cluster Pine

(*P. Pinaster* Ait.)

The cluster pine is a western Mediterranean species, growing naturally in southern France, Spain, Portugal, and Morocco. There it is an important timber tree and is also tapped for turpentine. It is used extensively for sand dune afforestation because of its ability to grow rapidly on deep sandy soils.

The only living specimens in the Philadelphia area are on the Morris Arboretum. They originated from seed sent to us by a South African forester who collected it from a racial test which he was conducting. Thus, they may be hybrids between different races. We have been pleasantly surprised at the performance of these trees. Coming from such a warm part of the world we did not expect them to survive more than a year or two. Yet they are now 10 years old and the only mortality has been due to girdling by labels which were not loosened in time. They have dense, dark green foliage and have been among the fastest growing trees on the Arboretum. (Fig. 40).

### Series Leiophyllae

This series contains two species from Mexico and the southwestern United States. Only one has been tried in this area.

### Chihuahua Pine

(*P. leiophylla* Schiede & Deppe var. *chihuahuana* (Engelm.) Shaw)

The Chihuahua pine is more common in northern Mexico than in the United States, where it grows naturally in only a few localities in the mountains of southern New Mexico and Arizona. It is interesting in three respects. First, it is the only pine for which 3 rather than 2 years are required for cone development. Second, it is

the only hard pine growing in the Philadelphia area which commonly bears needles in clusters of more than three (there are three to four needles per fascicle in Chihuahua pine). Third, it is the only hard pine growing in the Philadelphia area in which the sheaths surrounding the leaf fascicles are deciduous as in the soft pine.

The two specimens at the Westtown School arboretum were introduced several years ago by Mr. A. L. Baily, Jr., who dug them in Arizona and shipped them by express to Philadelphia during the heat of the summer. They are short-needled and open-crowned and will probably be of limited value in horticulture and forestry.

### Series Macrocarpae

Series MACROCARPAE is composed of three species, all endemic to California.

### Digger Pine

(*P. Sabiniana* Dougl.)

Digger pine is a native of the dry foothills of western California and of the central Sierras, occurring at elevations of from 500 to 4,000 feet above sea level. There it is a very distinctive feature of the landscape because of its sparse, gray-green foliage and rounded crown, usually no more than 50 feet. It was named after the Digger Indians, for whom its large seeds were a source of food. The two specimens in Philadelphia have grown at moderate rates and have the long, gray-green needles and loose habit typical of native trees in California.

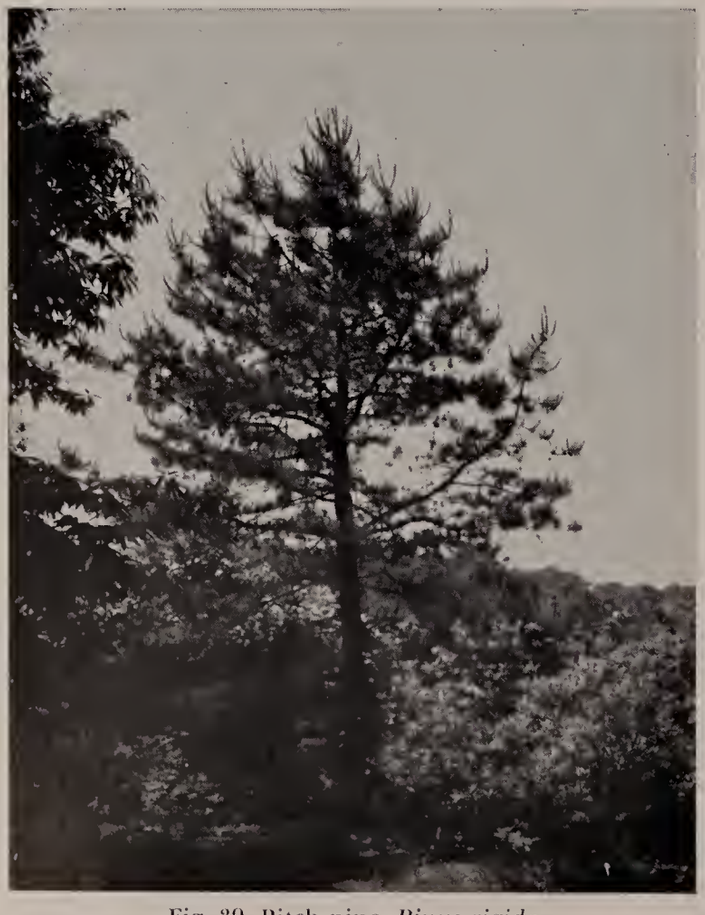


Fig. 39. Pitch pine, *Pinus rigida*

### Sources of Seed and Nursery Stock

All the commercially important United States, European, and Japanese species mentioned in this paper are regularly planted by the million and for those species commercial seed of high purity and germination percent is readily available at reasonable prices. Some dealers list three or four different geographic origins for such species as Scotch pine and nearly all are willing to supply seed origin data upon request.

Specially designed seed orchards have been established for the production of elite seed of some southeastern and European species. These orchards are in the trial stage and are not yet giving seed of proven genetic superiority. Most seed from those plantings is used for experimental purposes, very little being available from ordinary commercial sources.

The Chinese hard pines are the only species for which no truly reliable sources of seed now exist. Those species grow in remote areas and were hard to collect even before the present tense world situation. The grower interested in them can only collect cones from arboretum trees and hope that the resultant seedlings are not hybrids or selfs.

Many northeastern forest and Christmas tree nurseries regularly sell 2- or 3-year-old seedlings of red, Scotch, Austrian, mountain, jack, shortleaf, pitch, loblolly, and Virginia pines. Many of these same species are also available in larger sizes from ornamental nurseryman. The Pennsylvania grower who is interested in other species usually has to contact nurseries outside the region or grow his own. The latter course is preferable because pine stock which is shipped long distances frequently suffers heavy mortality. This is especially true for the southern species because southern nurserymen have to lift their stock many weeks before we are ready to plant in the North.

### Propagation of Hard Pines

The hard pines are most easily progagated from seed. The seed can be sowed directly in shaded, well-watered, outdoor nursery beds at a density sufficient to produce from 25 to 50 seedlings per square foot. Weed control, which used to be a major item in pine seedling production, is now easily accomplished by spraying with mineral spirits such as "Varsol". Many growers also fumigate their beds with one of the new weed-control chemicals before sowing. Some of those chemicals also control soil-borne insects and pathogens.



Fig. 40. Cluster pine, *Pinus Pinaster*

Some of the very fast-growing southern pines should be moved to their permanent locations when only one year old. Species such as Virginia and loblolly pines produce large tops in relation to their root systems and survival is much higher with naked-rooted first-year seedlings than with balled older stock.

For most northern species foresters usually use 2- or 3-year-old seedlings when establishing forest plantations. If such stock is kept moist and is planted properly in plowed strips or with a tree-planting machine, survival of 80 or 90 percent is common. Most planting is done in the spring to avoid frost heaving.

Propagation of the hard pines by cuttings is very difficult. Only if the cuttings are taken from young seedlings or consist of a single leaf bundle (such bundles usually fail to set a bud) is the rooting percentage likely to be high.

Southeastern workers have recently had very good success with pine grafts. The essentials for success in this grafting work are: (1) Use understocks which have been grown in place or which were potted up at least 6 months previously, (2) Use ordinary good grafting techniques as recommended for fruit trees, (3) Protect the completed grafts from desiccation by means of a plastic bag or grafting case until the union is complete. (4) If the grafts are made outdoors they should be shaded by a paper bag or a lath frame until the graft union is complete, and (5) Keep the grafted plants well watered. The best time for making pine grafts is still uncertain. Many southern workers prefer the period just after growth starts, and make their grafts on the newly expanding candles. Other workers have had better success in early spring, before growth starts.


## Acknowledgments

We wish to express our thanks to the many members of the staffs of the Northeastern Forest Experiment Station and the Morris Arboretum who have cooperated in the tree breeding research carried on by the Station. Special thanks are due H. L. Li, who took some of the pictures, and to J. M. Fogg, Jr. and E. J. Schreiner.

We made liberal use of the facilities of Westtown School, Westtown, Pennsylvania, and Haverford College, Haverford, Pennsylvania in the preparation of this report. Had it not been for the excellently maintained plantings at those schools our hard pine story would have been very incomplete.


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# Associates' Corner

## The Summer School

When Miss Lydia T. Morris left her property to the University of Pennsylvania to be maintained as an Arboretum, one of her stipulations was that an educational program should be one of its activities.

For many years the educational work of the Arboretum was largely confined to teaching classes of elementary school students and it was not until 1955 that instruction at the college level was offered. In the summer of that year Dr. Fogg, aided by members of his staff, conducted a course devoted to the study of Woody Ornamental Plants which was open to qualified graduate students. This course, now completing its fifth year, has grown in attendance from fourteen students in 1955 to twenty-eight in 1959.

Meanwhile the National Science Foundation had developed its far-flung series of Summer Institutes for High School Teachers of Science and Mathematics. The University of Pennsylvania was awarded one of these Institutes in 1957 and Dr. Fogg was appointed as its Director. The basic objective of these Institutes is to assist high school teachers to improve their knowledge of their subjects, emphasize recent advances in subject matter fields and stress present-day methods of teaching at the secondary school level, especially in the imaginative use of class room, laboratory and field techniques.

During the summer of 1959 there were 350 such institutes throughout the country with a total enrollment of approximaely 20,000 teachers. Each participant was granted free tuition, a stipend of $450, plus a travel allowance and a stipend of $90 for each dependent up to a total of four. The far-reaching influence of this program in improving the teaching of science is indeed significant.

As operated at Pennsylvania the 1959 Summer Institute included 100 participants (selected out of over 550 applicants) distributed among eight courses of instruction. These courses embraced chemistry, physics, mathematics, and biology. Most of the instruction was given in modern laboratories on the campus, but two of the courses in biology were conducted at the Arboretum, with its superb collection of mature native and exotic trees and its wide variety of geological types and ecological conditions.

One of these was a course in General Ecology which was taught by Dr. Francis C. Evans, Ph.D. (Oxon.), Professor of Zoology at the University of Michigan, assisted by Mr. Wilfred A. Kolman, a graduate student in Zoology at the University of Pennsylvania.

Although Dr. Evans was loaned to us by Michigan for the Summer session, it was really a case of "The Return of the Native," since he was born and grew up in Germantown and his mother was a Morris.

Dr. Evans' course dealt with the flora and fauna of the fields and streams, their contrasts and interrelationships, and the maximum life capacity of the two areas. In addition to utilizing the resources of the Arboretum, field trips were taken to the Pine Barrens of New Jersey, Island Beach, Bowman's Hill and other ecologically interesting localities. Dr. E. T. Wherry, of the University of Pennsylvania, and Drs. Murray Buell and John A. Small, of Rutgers University, assisted in these trips. Specimens were collected and studied in the Morris Mansion, which also served as headquarters for daily lectures.

Dr. Fogg's course on Woody Plants was given, as in the four preceeding summers, in the Gates Building with its fine library and herbarium facilities. The members of this class learned to recognize the many kinds of trees and shrubs growing in the Arboretum and also took field trips to a number of localities. Each student was enabled to assemble an herbarium of more than 500 species to be used in his own teaching or scientific work.

In addition to the instruction provided by Dr. Fogg, the class received lectures from Dr. Li on Conifers (a subject on which he is an authority), from Dr. Allison on the recognition and control of plant diseases and from Miss Milton on plant propagation.

Sixteen members of this class were high school science teachers whose attendance was made possible by the National Science Foundation. They represented several sections of the country and one of them came from the Hawaiian Islands. In addition there was, as in past years, a group of graduate students in Landscape Architecture from the University's School of Fine Arts. These students were introduced to the wealth of plant material available as elements of design. This group included students from England, Latvia and South Africa as well as this country.

One of the things I gathered from all this erudite education was that a spider is not an insect; I wonder if the spider knows that.

All joking aside, I feel we should be very proud of the fine educational work which the Arboretum is doing under Dr. Fogg's direction.

Marion W. Rivinus

# New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since March, 1959:

Mrs. Edward L. Altemus
Mr. George W. Bechtel
Mrs. Elizabeth C. Bennett
Mrs. R. T. Blackwood
Mr. John S. Clemens
Mrs. Lawrence Costello
Miss Blanche E. Davis
Miss Charlotte E. Eastwood
Mr. Leonard A. Falk
Mr. and Mrs. John T. Fite, Jr.
Mr. Logan B. Gill
Mr. George Ayres Hewitt
Dr. and Mrs. C. Marcus Hanna
Mr. Norman Hardy
Mrs. Helen D. Horsman
Mr. Nathaniel Jacobson
Miss Dorothy C. John
Miss Marilyn H. Johnson
Mr. Frederick W. Keith, Jr.
Mr. Edward Klavon
Mrs. Stephen J. Korn
Mrs. Elinor Lorant
Dr. Frank C. Lutman
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Mr. Murray Shapiro
Mrs. Walter T. Skallerup
Mrs. Arthur R. G. Solmssen
Mr. Charles R. Spang
Mrs. Edwin Van Sciver
Dr. Monroe E. Wall

# Arboretum Activities

(*Continued from Page 34*)

Following a visit to the Rose Garden our guests were served refreshments on the porch of the Morris Mansion.

### The Recreation Area

Completing its fifth season of service to campus organizations and the community, the Recreation Area was utilized this year by 54 groups with a total attendance of more than 4600 persons. The increasing popularity of this facility is indeed gratifying.

### From Our Guest Book

Among the eminent botanists, horticulturists and scientists who have visited the Arboretum in recent months are the following:

Dr. W. L. Koerber, Squibb Institute for Medical Research, New Brunswick, N. J.
Dr. Richard A. Howard, Director, Arnold Arboretum, Jamaica Plain, Mass.
Dr. Donald Wyman, Arnold Arboretum, Jamaica Plain, Mass.
Dr. Neil Murray, Roebuck Park House, Dublin, Ireland.
Dr. Hugh B. Loveland, Assoc. Prof. of Botany, Colgate Univ., Hamilton, N. Y.
Dr. E. S. Rex, Rutgers College of Agric., New Brunswick, N. J.
Dr. Robert B. Clark, Rutgers College of Agric., New Brunswick, N. J.
Dr. Richard W. Pohl, Professor of Botany, Iowa State University, Ames, Iowa
Dr. Wendell P. Ditmer, State Botanist, Penna. Dept. of Agric., Harrisburg, Pa.
Dr. J. J. Christensen, Professor of Plant Pathology, University of Minnesota, Minneapolis, Minn.
Dr. Faustino Miranda, Universidad de Mexico, Mexico, D. F.
Dr. E. Hernandez, Escuela Nacional de Argicultura, Chapingo, Mexico.
Dr. Cynthia Westcott, 96 Essex Ave., Glen Ridge, N. J.

J. M. F., Jr.

# Morris Arboretum Bulletin

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*Robinia pseudoacacia*

Published by
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THE MORRIS ARBORETUM

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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# Arboretum Activities

## The Staff

From October 7 to 10 the Director participated in the Annual meetings of the American Horticultural Council and the American Association of Botanical Gardens and Arboretums which were held at Rochester, New York. On November 6 he attended the semi-annual session of the Visiting Committees for the Arnold Arboretum at Jamaica Plain, Mass.

October 26 was the official date of publication of a new book by Dr. H. L. Li entitled "The Garden Flowers of China." This volume is reviewed elsewhere in these pages. A revised and enlarged edition of Dr. Li's "Chinese Flower Arrangement" was published by D. Van Nostrand Company on November 20.

Miss Mary Milton and Mr. Fairman Jayne represented the Arboretum at the meetings on the American Holly Society which took place at Easton, Md., on October 31.

## Floriade

One of the important topics discussed at the A.A.B.G.A. meeting in Rochester on October 10 was the participation by the member institutions in the forthcoming international horticultural

(*Continued on Page 67*)

# The Black Locust and Honey Locust[1]

Hui-Lin Li

The early American colonists, like all other immigrating people, were at first more interested in trees of their original homes than in the native plants of their adopted land. Since the very beginning efforts were made to introduce nearly all important cultivated species of European trees into America, in spite of the fact that practically all of these have their counterparts in eastern North America. Moreover species of the same genera that are indigenous are more suitable to the local climate. The American flora is actually far richer than that of Europe. Not only are more genera represented, but there are usually more species in the same genus in America than in Europe.

Only a few of the native American trees were thus cultivated during early colonial times, while most others were not introduced into cultivation until the eighteenth or nineteenth centuries. The cultivation of native trees gained great momentum toward the end of the last century as a result of wider interest in gardening, conservation, and tree culture as well as the establishment of numerous arboretums and botanical gardens throughout the country. Since then nearly every important native species of trees has been in cultivation one way or another.

The trees of American origin therefore have a much shorter history of cultivation than most other important trees from Europe and Asia. Within the short span of about three hundred years, however, two outstanding species have already gained world-wide recognition, and are sometimes more extensively cultivated and better known in some other parts of the world than in their native home. The two species, both plants of the Pea or Legume family, are the Black Locust and the Honey Locust.

## The Pea Family

The Pea family, Leguminosae, is one of the largest families of flowering plants. The very numerous genera and species, estimated at over 500 and 8,000 respectively, are widely distributed all over the world and are most abundant in the tropics.

As food plants the many edible legumes are second only to cereals in importance. Because of the fact that they are very rich in proteins, their use supplements the high carbohydrate contents of cereals. In many parts of the world peas and beans actually take the place, in part or nearly in whole, of foods derived from animals.

The Leguminosae have a unique susceptibility to certain root-inhabiting, nodule-forming bacteria that synthesize nitrates from free nitrogen. This process is an extremely important one, because atmospheric nitrogen cannot be used by higher plants in the lengthy process leading to protein formation.

Part of the nitrates formed by the bacteria can be utilized by the leguminous host plants, and part eventually by subsequent crops. Thus, the high nitrogen content of legumes not only contributes to the food value of beans and peas, but also makes these plants useful as fodder and for enriching the soil. The importance of legumes to human economy and agriculture is indeed very great.

## The Black Locust

The Black Locust, *Robinia pseudoacacia,* is one of about 20 species of a genus which in North America is distributed from Pennsylvania south to Mexico. Some of the species are of tree size while others remain as shrubs. The Black Locust is the most wide-spread and the most commonly planted species. It is also known as Locust, Common Locust, Yellow Locust, White Locust, and Acacia. The name Locust was given by early missionaries who fancied that the tree was the one that supported St. John in the Wilderness (Loudon 1838). It is, of course, an American tree which is not native to any other part of the world. The true locust of the New Testament is most probably the Carob, *Ceratonia siliqua.*

The Black Locust is a medium-sized tree, usually attaining a height of about 45 feet, but may reach as much as 75 feet. The reddish dark brown bark, deeply furrowed and ridged, is quite distinct in appearance. The branches and branchlets bear sharp spines at the nodes, usually in pairs. The feathery odd-pinnately compound leaves, dark green in color, and the large drooping clusters of very fragrant white flowers together make the tree a highly ornamental one. (Fig. 41).

[1]Fig. 42, courtesy of Edward H. Scanlon, Trees Magazine. Figs. 43-45, courtesy of Vogin Vasilic, Director, Zavod za Kulturu topola, Novi Sad, Yugoslavia; received through Dr. E. J. Schreiner.

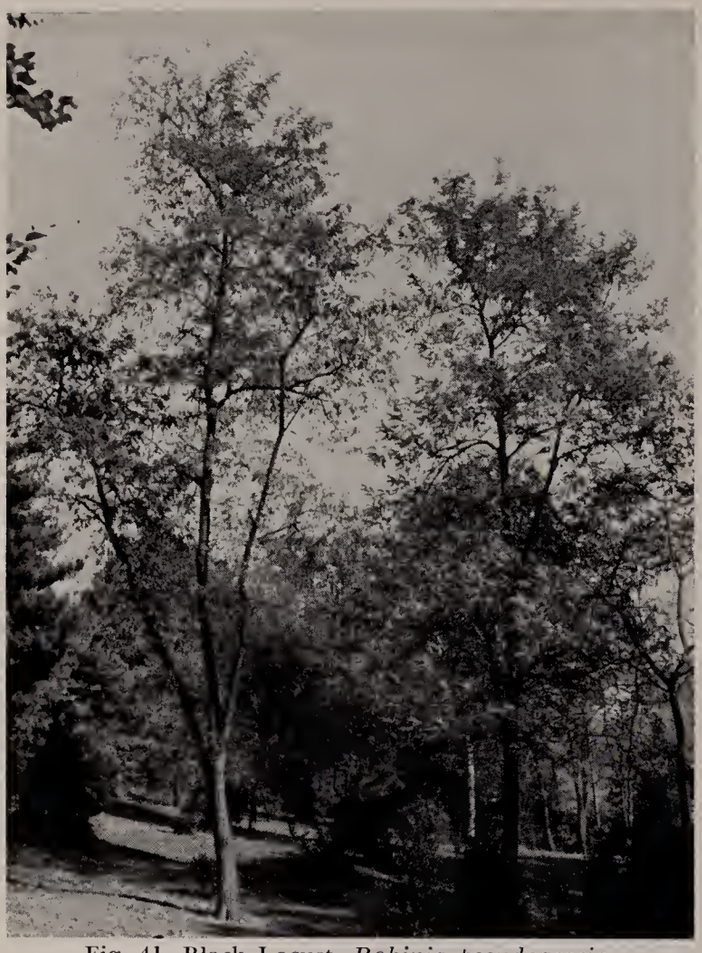


Fig. 41. Black Locust, *Robinia pseudoacacia.*

As noted above, the Black Locust has the widest range of all species in the genus. The original habitat extended from the mountains of Pennsylvania to Georgia and westward to Iowa and Kansas and Oklahoma, but it is now widely naturalized in many other parts of North America. Several insects, the Locust borer and Locust leaf miner, and the fungal Locust rot are doing considerable damage to the trees locally. The tree occurs in a wide variety of conditions. On moist fertile soil, along streams or on rich bottomlands, it grows especially vigorously but it also thrives on rocky sterile slopes.

## Uses of the Black Locust

The wood of the Black Locust is of excellent quality, especially in straight and clean forest-grown specimens free from insects or other enemies. It is very hard and strong, yellowish brown to reddish brown, with thin greenish or yellowish sapwood. It is very durable in contact with soil. In former times it was used extensively for ship-building. It is now used for posts, poles, or ties, for tree nails, insulators, pins and fuel.

The Black Locust, like many other legumes, has nodules on the roots. It can be used as a soil improver for pastures or bare lands. The leaves may be used as fodder. The tree is also an important honey plant.

The use of Black Locust in former times as tree-nails in the construction of wooden ships is of particular interest. These nails, the thick long wooden pins holding together timbers, were subject to great stresses. In colonial times, the Black Locust nails were used with great success, owing to their great strength together with amazing decay resistance. By 1820 Philadelphia alone exported between 50,000-100,000 locust nails to England annually. A member of Parliament rose to point out that unless the British Navy adopted Black Locust tree-nails it could not hope to equal the American ships (Schramm 1942).

## Introduction of the Black Locust into Cultivation

The Black Locust is perhaps one of the very few trees planted by Indians in the temperate regions of North America before the arrival of the colonists. It appears to have been common in the neighborhood of the coast when Virginia was first settled by Europeans (Sargent 1892). William Strachey, who first visited the colony on James River in 1610, mentioned this tree in his *Historie of Travaile into Virginia Britannia.* He found that "by the dwelling of the salvages are bay-trees, wild roses and a kynd of low tree, which beares a cod like to the peas, but nothing so big: we take yt to be locust."

The Indians made their bows from the wood of the Locust. According to Sargent (1892), it is quite probable that the Indians of Virginia carried the tree from the mountains to the low country and so helped the tree to spread beyond the limits of its original natural forests along the slopes of the Appalachian Mountains.

The exact date of its introduction into Europe cannot be ascertained. Some authors, such as Linnaeus and Miller, claim it was 1601 when the botanist Jean Robin after whom the genus was named, is said to have obtained seeds from America; others such as Adanson and Deleuze maintain that it was not until 1636 when it was planted in Paris by Vespasien Robin, son of Jean Robin. This particular tree, the oldest known of its kind in Europe, is still living in the gardens of the Museum d'Historie Naturelle. (Fig. 42). The English, however, might have introduced the tree into England at an earlier date as John Parkinson, who published the first description of the tree in 1640 in his *Theatrum Botanicum,* observed that the Locust had been raised near London by Tradescant to already "an exceeding height." (Elwes & Henry 1912).

In the seventeeth and early eighteenth centuries, the Locust had attracted great public attention in Europe and numerous papers had been published on its horticultural value. (Elwes & Henry 1912). In 1892 Sargent was to write that, "No other North American tree has been so generally planted for timber and ornament in the United States and in Europe; and no inhabitant of the American forest has been the subject of so voluminous a literature."

The tree has since been planted in nearly all countries in Europe, and in South Africa, North Africa, South America, Asia, Australia and New Zealand (Spaulding 1950). In many countries the Black Locust is the most extensively used tree for reforestation. (Blümke 1956).

## The Shipmast Locust

A number of geographical strains or races of the Black Locust have been reported but most of these are probably differences resulting from environment. Among these, the most outstanding and distinct is the variety 'Rectissima', the Shipmast Locust, described from Long Island by Raber in 1936 but introduced there apparently over two centuries ago possibly from tidewater Virginia. The lasting quality of the wood of this tree is probably unsurpassed by any other in the eastern United States. Fence posts over one hundred years old have been resold for further use. This is a wood that can be adapted to many special uses. The Morris Arboretum made use of the timber in constructing greenhouse benches in 1942 (Schramm 1942) and in building a lath house in 1949 (Skinner 1949). The latter structure is in good condition after ten years.




Fig. 42. The Robin Black Locust in Paris.

## Variations of the Black Locust in Cultivation

A large number of varieties of the Black Locust have arisen in cultivation (Sargent 1892, Rehder 1940). The more important and distinct ones are here enumerated. Nearly all of these originated in European, especially French gardens in the nineteenth century. They are mostly propagated by grafting.

1. 'Crispa' — An unarmed form with undulate or crinkled leaf margins; originated before 1825.
2. 'Decaisneana' — A vigorous tree with light rose colored flowers; originated before 1860.
3. 'Dissecta' — A compact tree with short branches and dissected leaves; originated before 1869.
4. 'Inermis' — Unarmed; originated before 1904. This is the form usually planted in Europe for fodder.
5. 'Latisiliqua' — Pods broad; originated before 1829.
6. 'Macrophylla' — Leaves long and leaflets broad; originated before 1830.
7. 'Microphylla' — Leaflets small and narrow; originated before 1830.
8. 'Pendula' — With somewhat pendulous branches; originated before 1820.
9. 'Pyramidalis' — A form with unarmed erect branches forming a narrow pyramidal head; originated in 1839.
10. 'Tortuosa' — a distinct form with short twisted branches, short in stature and slow in growth and usually few-flowered; originated before 1810.
11. 'Umbraculifera', Parasol Acacia. — An unarmed form with short branches forming a dense spherical head; originated before 1810. This is the form much used in Europe by grafting high for formal planting. It is also



Fig. 43. Parasol Acacia, Novi Sad, Yugoslavia — old trees.

one of the most popular street trees in central and northern Europe. It rarely produces flowers. (Figs. 43-45).

12. 'Unifolia' = 'Monophylla' — A form with the leaves sometimes reduced to one large leaflet or more often with 2-3 leaflets or more; originated in 1855. (Figs. 46 & 47).

### Other species of Robinia

With the exception of the Black Locust, the other species of the genus *Robinia* are mostly shrubs or, at most, small trees. They are cultivated only occasionally, and generally used locally as ornamentals for their showy and often fragrant flowers. The most commonly planted one is the Clammy Locust, *Robinia viscosa,* a small tree which grows to a height of about 35 feet. The tree can be readily distinguished from the Black Locust by its stiff glandular viscid reddish brown hairs densely covering the young branches. The leaflets are more numerous (13-25) than in the Black Locust (7-19). The tree is native to southeastern United States and has been cultivated since the late eighteenth century.

Among the shrubby species, the more commonly planted are *Robinia hispida* and *R. fertilis,* both natives of southeastern United States. These species grow to a height of only 3-6 feet and are planted mainly for their showy rose-colored flowers.

### The Honey Locust

The Honey Locust, *Gleditsia triacanthos,* is a native of the eastern part of North America, extending from Ontario through Pennsylvania to Florida, westward to Kansas and Texas. It is now widely planted and in many places it has escaped cultivation and become naturalized. In some parts of the country it is also called Sweet Locust, Three-horned Acacia, Thorn Tree, Honey Shuck, or Black Locust.

The tree is of medium size attaining usually a height of about 50-100 feet, but sometimes it may grow to a height of nearly 150 feet. The trunk is usually short, branching low, but in close stands it may be rather long and clean. The bark is grayish brown to almost black, usually rough with a few fissures and thick, firm broad ridges. It is often covered with stout, simple or 3-branched thorns which are frequently also found on the twigs. The long even-pinnately once- or sometimes twice-compound leaves are quite ornamental. The greenish flowers, in male and female clusters, are very fragrant. The distinct large leathery fruit pods measure one to one and a half feet long. (Fig. 48).

The Honey Locust is a rapidly growing tree. In its original habitat, it develops best in rich soil along moist bottomlands, but it will grow in any fertile soil which is not too wet. It is a light-demanding tree.

### Uses of the Honey Locust

The wood of forest-grown trees of the Honey Locust is of excellent quality, but in open-grown trees, it usually becomes too knotty. The wood is hard, coarse-grained, strong, heavy and durable in contact with the soil. It is bright reddish-brown in color with thin pale sapwood. It is used mainly for fence posts, poles, ties, fuel and lumber for general construction.

The Honey Locust is a highly ornamental tree but as a shade tree it is not satisfactory on account of its late leafing in the spring. The tree is an important honey plant. According to Smith (1950), it lacks the root nodules common to most legumes. The pods are edible and can be used as a valuable stock food.

### Other species of Gleditsia

The genus *Gleditsia* is composed of about twelve species, distributed in North and South



Fig. 44. Parasol Acacia, Novi Sad, Yugoslavia young trees not trimmed for 4-5 years.



Fig. 45. Parasol Acacia, Novi Sad, Yugoslavia — trimmed young trees.

America, and in the Old World in Central and Western Asia and in tropical Africa. Besides the Honey Locust, there are two other species in North America. The Water Locust, *G. aquatica,* inhabits river swamps of southeastern and southern United States. The Texas Honey Locust, *G. texana,* occurring in the U.S.A. from Mississippi to eastern Texas, is believed by Sargent (1902) and Elwes & Henry (1912) to be a putative hybrid between the Honey Locust and the Water Locust.

A number of species from eastern Asia are now in general cultivation. The most important cultivated species there is *G. sinensis,* a medium-sized tree quite similar to the American Black Locust in general appearance. This is the famous "Soap-pod Tree" in China, where the pods have been used since ancient times as soap by boiling in water and producing lather. This is used especially for cleaning furniture as it will not damage any wood structure.

### Introduction of the Honey Locust into Cultivation

The Honey Locust was cultivated early by American colonists sometime in the late 17th century. The first account of it, drawn from the cultivated tree, was published by Plukenet in 1700 in his *Amalthum Botanicum,* with a brief description and illustration.

The tree was first cultivated in Europe by Bishop Compton in his garden at Fulham near London in about 1700 (Aiton 1789, Loudon 1838). It was known in France in the early eighteenth century and spread shortly afterwards to other European countries.

Since its first introduction into cultivation, both in America and in Europe, the Honey Locust has been extensively planted. Its readiness to grow from seed, rapid growth, easy culture, extreme hardiness are among the commendable characters that make it popular for planting in gardens, parks or along highways. Its only drawbacks are its lateness in sending out leaves in the spring and a serious insect pest, the mimosa webworm in the Philadelphia area. An especially desirable character of the tree is its ready adaptibility to any soil conditions.



Fig. 47. *Robinia pseudoacacia* 'Unifolia' — variation in leaves.



Fig. 46. *Robinia pseudoacacia* 'Unifolia'.

The Honey Locust is cultivated in most countries as an ornamental tree. It has been reported to be useful as a fodder in Australia and other places. It is doing well in such wide-ranging areas as the steppes of southern Russia and Tunisia in Africa (Smith 1950), and is reported also in cultivation in South Africa and South America (Spaulding 1956).

### Variations of the Honey Locust in Cultivation

*Gledistia triacanthos* is a more or less uniform tree with few variations. In its natural populations or in cultivation, there appear occasional individuals which are unarmed or nearly unarmed, and these trees are usually of slender habit. These plants are referred to as f. *inermis*. In cultivation, only a few variations have appeared as follows:

'Bojutii' = 'Pendula' — A tree with graceful pendulous branches and small narrow leaflets; originated before 1845 from cultivated plants in France.

'Elegantissima' — Of dense bushy habit, unarmed and with smaller leaflets; originated about 1880 in France.

'Nana' — A somewhat smaller more compact shrub or tree with shorter, broader, dark green leaflets; originated before 1838 in England.



Fig. 48. Honey Locust, *Gleditsia triacanthos*.

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## New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since September, 1959:

Bonsell & Troutman

Mr. Joseph P. Diviny

Edison High School

Mr. and Mrs. Edward Fischer

Mrs. E. Hendricks Funk, Jr.

Mr. Fairman R. Furness

Mr. and Mrs. C. C. Henley, Jr.

Mr. Francis J. Hoban

Mrs. Paul O. Klingensmith

Mrs. John K. Knorr, III

Mrs. Elinor D. Lamade

J. Franklin Meehan & Sons Inc.

Mrs. Allen J. Sprow

# The Testing of Tree Seed in the Laboratory and in the Nursery

C. E. Heit[1]

Tree seed testing for mechanical purity analysis and for percentage of germination has not been practiced in our country as widely as the testing of most agricultural seeds. There have been many reasons for this fact such as the lack of knowledge of the germinative characteristics of tree seed by the seed analysts. Also the nurseryman, forester and planter have thought that tree seed could not be tested in the laboratory. The volume of tree seed was relatively small compared with other seeds, and the demand for good germination and high quality tree seed has been lacking.

The writer has been closely associated with seed germination studies since 1928 both in the commercial and State nursery propagation field and recently in research work and seed testing at the N. Y. State Agricultural Experiment Station. He has observed many times the crop failures in nursery seedbeds which were due to poor, old, weak or actually dead seed. This seed was either collected or purchased by the nurseryman and was planted without definite knowledge of its germination value. Sometimes he had too much faith in the seed dealer who sold the seed to him thinking that the germination would result in a good field stand (see Fig. 55).

One progressive seedsman and nurseryman as early as 1887 clearly stated that tree seed needed a thorough system of seed testing and the adoption of the principle that all samples of seed should be tested by an authorized laboratory and that such seed should pass a specified test before being issued to planters. Within the past 10-15 years and particularly within the last 5 years nurserymen, tree seed collectors, dealers and private planters in our country have become more seed quality conscious. They are requesting germination tests on the seed which they collect, sell or plant. They are also demanding that seed analysts furnish them with this information in a reasonable length of time.

Since 1940 the writer has been studying the optimum conditions of light, temperature, moisture and substratum on the germination of tree seed with the idea of developing a standard method for testing each species which would give rapid and complete germination in the shortest time. Such factors as dormancy, seed source variation, abnormal germination and seed vigor were given careful attention.

## Temperature and Light Factors in Germination

In the early years of the studies it was found that temperature and light were two very critical factors in securing optimum germination. The effect of light and temperature on dormancy in Scotch pine seed was reported in 1940 by Eliason and Heit (2). Recently the writer (6) published the findings of 18 years study on the germination of ten hard pine species. Suggested methods for testing these pines in the laboratory were given, all of which can be tested within 14-21 days. It was found that there was no need for long test durations with any of these pine species when optimum temperature (a 20-30°C alternating) and artificial light conditions were maintained during these tests. Copies of this article as well as the writer's other two articles cited under literature will be sent upon request. Both Figures 49 and 50 show clearly the stimulating effect of artificial light upon germination in the laboratory of Scotch and Austrian pine. It must be necessary to have temperature and moisture at the optimum also as any one factor may be a retarding influence on rapid and complete germination. Note the germination percentages of 92-98% in Figure 49 after 6 days yet under less optimum conditions these same lots germinated only 30 to 90% at the same time.

Light may have a stimulating effect upon germination at various temperatures (Fig 50) but some temperatures themselves will retard or prevent actual germination and then light ceases to function as a stimulating factor. Most coniferous trees did not respond well at temperatures

[1] Mr. Heit is Seed Technologist at the Department of Seed Investigations, New York State Agricultural Experiment Station, Geneva, New York. Besides research studies this Department maintains a seed testing service for individuals, seed dealers, and various agencies for labeling and planting purposes. It also tests seed for law enforcement purposes in cooperation with the N. Y. State Department of Agriculture and Markets.

Prior to 1940 Mr. Heit was connected with the New York State Conservation Department for 9 years in nursery production and investigation studies on seed testing and dormancy problems. For three years he was associated with one of the largest wholesale nurseries in the United States in their evergreen propagating department.

For the past 15 years he has operated a small personal experimental seedling and transplant evergreen nursery in which he specializes in seed source studies of pines, spruces and firs. Many exotic kinds of these three groups are being grown, tested and distributed to Christmas tree growers and nurserymen.

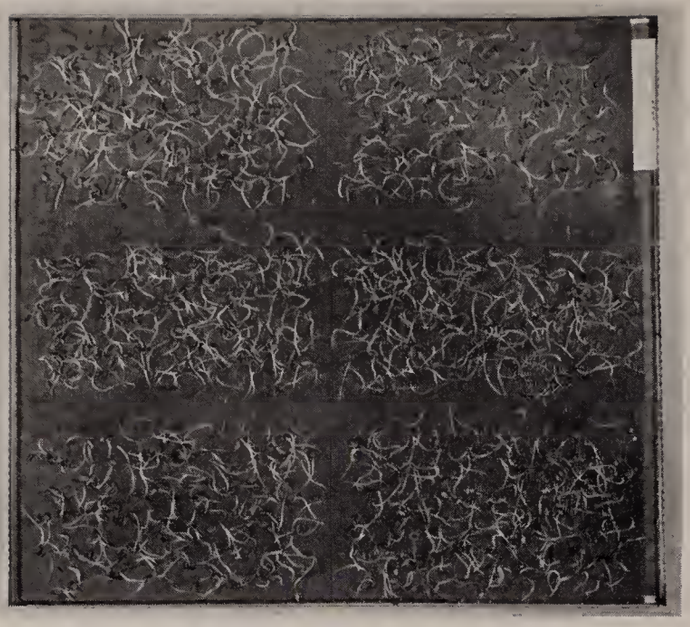


Fig. 49. Rapid, maximum germination of Scotch pine seed from 6 native Spanish sources after 6 days on top of blotter at 20-30°C alternating temperature in fluorescent light during the 8-hour high temperature period. Germination varied from 92-98%.

of 15°C or oftentimes 20°C. Most of the spruces, hard pines and some firs and cedars will germinate readily and completely at 20-30°C alternating temperature with the addition of artificial light within 10-30 days without any prior moist prechilling or stratification treatment. These findings are in disagreement with beliefs published years ago by Barton (1) and by recommendations as recently as May 1959 by Swofford (8), who still suggested pretreatment of 30-60 days at 3°C for several hard pines including *Pinus echinata, P. rigida, P. sylvestris* and *P. Taeda* before germination test.

### Hardseededness and Embryo Dormancy

Some tree seed exhibited hard seed coats such as the locusts, redbud, sweetshrub, sumac and many others. These seed must be clipped, filed, scarified, or treated with sulphuric acid so as to allow water to penetrate the seed itself and embryo before germination will occur. The effect of concentrated sulphuric acid treatment on an extreme hardseeded lot of staghorn sumac is shown in Fig. 51. It actually required 6 hours treatment with this lot to secure prompt maximum germination of all viable seed. It will be interesting for the readers to note that this lot of sumac seed which showed no germination in the check or untreated seed in the photo is still in the germinator after 15 years. At present the check or untreated seed has germinated 2.5% and the one hour acid treatment lot has germinated 11%. These seeds have been under constant moist germinating conditions at room temperature and counts are recorded yearly or as necessary. One-half to one hour acid treatment is usually sufficient to secure germination with most hardseeded tree species.

Some tree seed exhibit extreme dormancy and will not respond to germination in the laboratory unless the seed is after-ripened at 3-5°C for 1-4 months. Most of the white pine group, hemlock, some firs, fruit seed, and many hardwood and shrub seed require this pretreatment before the seeds will actually produce normal germination. Once this moist prechilling and after-ripening treatment has taken place it has been generally assumed that the prechilled seed will germinate promptly at most any temperature. Our studies have found that even prechilled seed of some tree species are sensitive to temperature during germination. It was found that prechilled seed of certain species will not germinate satisfactorily if placed at too high temperatures (especially constant) for their germination test. Figure 52 shows the response of completely after-ripened apple seed when it was placed to germinate at temperatures of 15° and 25°C. At 15°C rapid, complete, uniform, germination of 98% was secured after 5 days while only 35% was secured at 25°C after 5 days, 42% after 10 days, and only 66% germination after 21 days. The seed will revert back into dormancy again when placed at these undesirable temperatures. Many temperatures were studied in similar tests but most consistent germination results were secured with prechilled apple and pear seed when it was germinated at temperatures about 15°C.

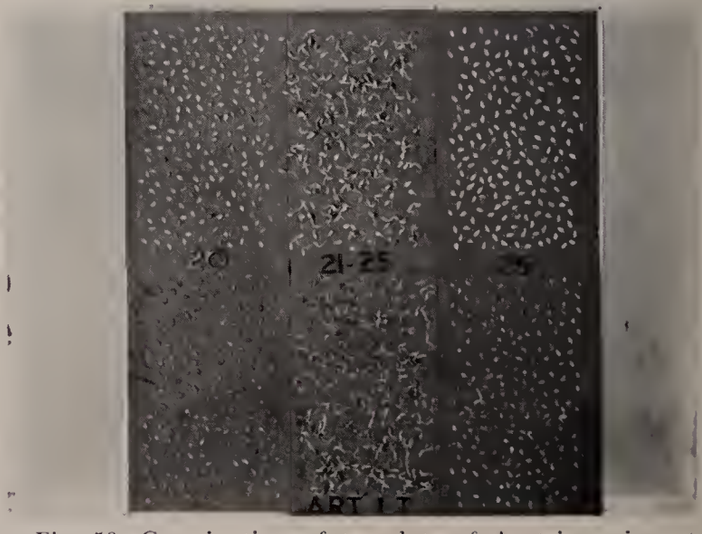



Fig. 50. Germination of two lots of Austrian pine at 20° and 25°C in closed, dark germinators; center lot in constant artificial fluorescent light with temperature varying from 21-25°C. Note 95-100% sprouting in artificial light after 5 days.



Fig. 51. The effect of concentrated sulphuric acid treatment on staghorn sumac (*Rhus typhina*) seed in laboratory testing after 10 days. From left to right, Check — no acid; 1, 2, 3, 4, and 6 hours — $H_2SO_4$ at room temperature respectively. Germination varied from 0% to 52% germination after 6 hours.

### Laboratory Testing by Embryo Excision

The seed analyst must be able to test seed for germination in a reasonable length of time to be of any value to the seed dealer, buyer or planter. The embryo excision method for determining approximate viability in extreme dormant seed was first reported by two workers, Flemion (3) and Tukey (9). The writer has used this method for testing forest tree seed such as ash, certain pines and magnolia since late 1930 and in 1955 published a summary (5) of twenty years study on this method. A compilation of literature is given on this method including 29 references several by Flemion and numerous other research workers. A complete list of nearly 100 kinds of flowers, vegetables, shrubs, vines, and fruit, coniferous and broad-leaved trees is also given on which the writer has tested successfully by this embryo excision technique. Six figures are also shown depicting the embryo response of various types of seeds.

The embryos are removed from the seed after soaking the seed in water from 1-4 days. These embryos are placed in closed dishes on a moist substratum in light at temperatures preferably between 62°-72° F. Good, live seed will germinate, show some greening of the embryo or spreading of the cotyledons or remain firm and white. The weak or dead embryos will discolor, severely mold or decay. Details of this method of testing can be found in the published summary or the many references listed therein. Techniques of seed pretreatment and subsequent embryo removal vary with the kind and type of seed to be tested. Figure 53 shows the response of 4 peach stocks tested by the embryo excision method. Reliable results can be secured in 5-15 days by this method which might take 1-5 months by normal germination of afterripened seed in these extreme dormant species.

### Other Quick Tests

Many other so-called quick tests have been developed and tried on dormant tree seed during the years including chemical reactions, electrical response, specific gravity, catalytic activity, etc. The most recent and most widely publicized quick test is the tetrazolium chloride staining method. The writer has used this tetrazolium test on many kinds of tree seeds and found it to be unreliable especially with weak or old seed stocks. Flemion concluded, after comparing this staining test with the embryo excision test, that the results were too irregular to recommend it as a method for testing any given species.

The writer believes the tetrazolium chemical test serves a purpose and on certain extreme dormant species when the embryos cannot be excised it does give indication whether the seeds are live or dead and is more accurate than the old fashioned "cutting" or "hammer" test. As an emergency test it also has some value at times and as a supplementary test on certain seed lots it has been helpful.

### Abnormal Germination, Weak Seed

The seed analyst must be constantly alert in testing seed so as to detect abnormal germination and weakened vitality in certain seed lots. Tree seeds quite frequently show abnormal germination. Mechanical injury during the extraction or cleaning of tree seed may cause abnormal germination. Poor storage conditions or aging of the seed is the most common cause of poor, weak, abnormal germination. Only those seeds which germinate and produce a normal, vigorous seedling should be counted as germination

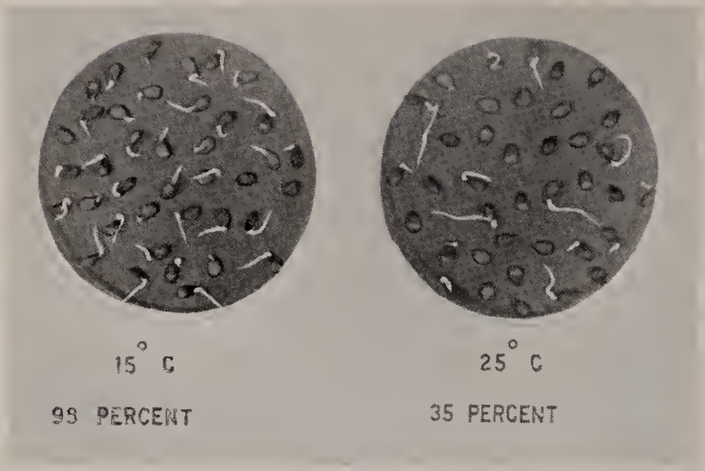



Fig. 52. Difference in germinative response of prechilled apple seed after 5 days at two constant temperatures of 15°C and 25°C. Note rapid, uniform germination when seed was placed at 15°C.

percent. Figure 54 shows normal and abnormal germination in Austrian and red pine. The radicle is the important structure of any tree seedling and unless the root tip is vigorous, active and healthy one must beware of trouble. Slow, weak abnormal root development during laboratory testing with profuse fungus growth on the seeds definitely indicates that the stock has weakened vitality with doubtful seeding value.

### High Quality Tree Seed Possible

The quality of tree seed is dependent upon the proper use of methods of collection, extraction, cleaning and storage. With our modern machinery today, the mechanical purity of most tree seed should be 95-100% pure and nearly free of foreign material such as needles, leaves,

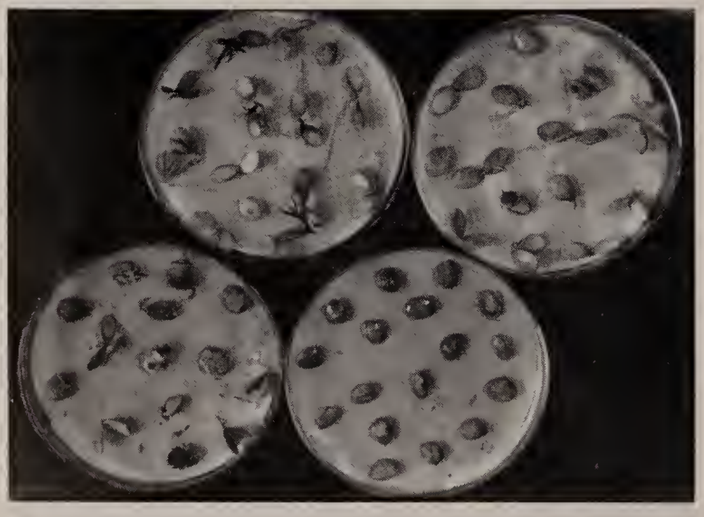


Fig. 53. Comparison of vigor and growth of 4 peach stocks tested by the embryo excision method. Upper left — strong seed, vigorous growth; Upper right — good reliable stock, fair vigor; Lower left — weak, old, moldy, doubtful planting value; Lower right — dead, no embryo activity. Actual germination of these stocks after being properly after-ripened were 80, 52, 18, and 0% respectively.



Fig. 54. Laboratory germination of Austrian pine (left) and red pine (right) showing normal, good germination with strong seedling development and weak, abnormal stunted germination which will not produce tees in field plantings. Note vigorous, healthy root on normal seedlings.

stems, dirt, stones, cone scales, wings and resin. Empty seed can be eliminated in all pines, spruces, hemlock and some firs. They can be greatly reduced in larches, cedars, and firs by proper screening and blowing. Mature seed freshly collected of pines, spruces, hemlock, and some other conifers should be 90-100% viable. Many commercial seed lots testing during the past few years at the Geneva laboratory have shown over 90% germination and over 98% mechanical purity. Unclean seed with excessive inert matter or empty seed should not be accepted by any nurserymen.

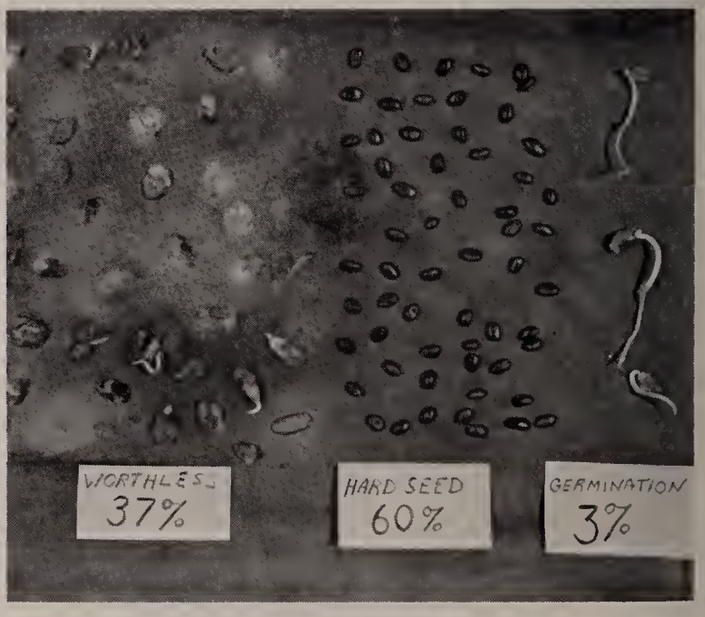



Fig. 55. Laboratory response of honey locust seed which had been purchased from a dealer, planted in the nursery with a stand failure. Note dead seed, only 3 weak sprouted seedlings. Most of the hard seed were found to be dead in test.

## Make Seed Dealer Responsible

Nurserymen, foresters, Christmas tree growers and private gardeners should make the dealer responsible for the quality of the seed which he sells. Many nurserymen have bought seed blindly in the past as was experienced by the company which planted the honey locust seed shown in Figure 55. After buying the seed, paying for it and then planting the seed without a germination test no field stand was secured. Our laboratory was contacted and a test of the remaining seed showed the seed to be unfit for planting. The 3% of weak germination did not produce in the field and although a small percentage of the hard seed was found to be viable it was not strong enough to grow vigorous healthy seedlings.

New York State has provisions in its seed law to protect the buyer of tree seed. Tree seeds offered for sale within this state must be correctly labeled as follows:



Fig. 56. Several seed sources of Scotch pine in rows showing variation in height growth and needle length as 2-2 transplants. Even the yellowish coloration is showing in the riga source at extreme right. The front center stake shows a Spanish strain 1-1½ ft. in height. The two fast growing long-needled strains at right by yardstick are North German and Polish strains 2½-3 ft. in height. Photo taken November 1.

(1) The kind of seed and the variety.
(2) The percentage by weight of pure seed.
(3) The percentage of germination.
(4) The year of collection of such seed.
(5) The specific locality (state and county in the United States or nearest equivalent political unit in the case of foreign countries) in which seed was collected.

Other states including Georgia, Michigan, Massachusetts and Pennsylvania have some provisions regarding the labeling of tree seed in their law. Some progressive, reliable tree seedsmen are making germination tests on all or part of their seed which is being offered for sale. It is the buyer's responsibility to know the quality of the seed he purchases from the dealer. Request the dealer to furnish you with a germination percentage on each lot of seed and then have it tested at a seed laboratory for your own protection. By buying only high quality seed and knowing the actual germination of the seed, you can regulate the seeding rate so as to secure optimum seedbed density for maximum growth of strong, healthy seedlings.

## Seed Source and Exotic Tree Studies

The writer has conducted research studies in an experimental personal nursery for over 15 years on many different seed sources of Scotch pine, Austrian pine, mugo pine, Douglas fir, Colorado blue spruce, Norway spruce, yews and other species. Close, observations on growth habit, rate of growth, needle length, winter coloration, winter hardiness and other characteristics have been made and recorded. Many of these special sources have been sold to Christmas tree growers and nurserymen for future study and observation. Special attention has been given to Scotch pine and Douglas fir the past 5 years for the Christmas tree growers in New York and Pennsylvania. At present the writer has tested over 40 known sources from nearly all countries in Europe from Sweden to Spain and from England to Turkey. Figure 56 shows several seed sources of Scotch pine as 2-2 transplants taken November 1. Height growth varied from 1-3 feet; needle length varied widely; winter coloration was yellow to blue-green, and type of growth varied considerably from one source to another. All sources tested are not shown in photo and several other series have been tested other years.

Douglas fir has extremes in color, height growth and winter hardiness depending on strain and locality collected. Under test this year is a series of 8 different glauca sources and 8 different green or grey sources.

Many exotic firs, pines and spruces from the West coast, Europe and Japan are being grown for study and distribution. Two of the spruces,

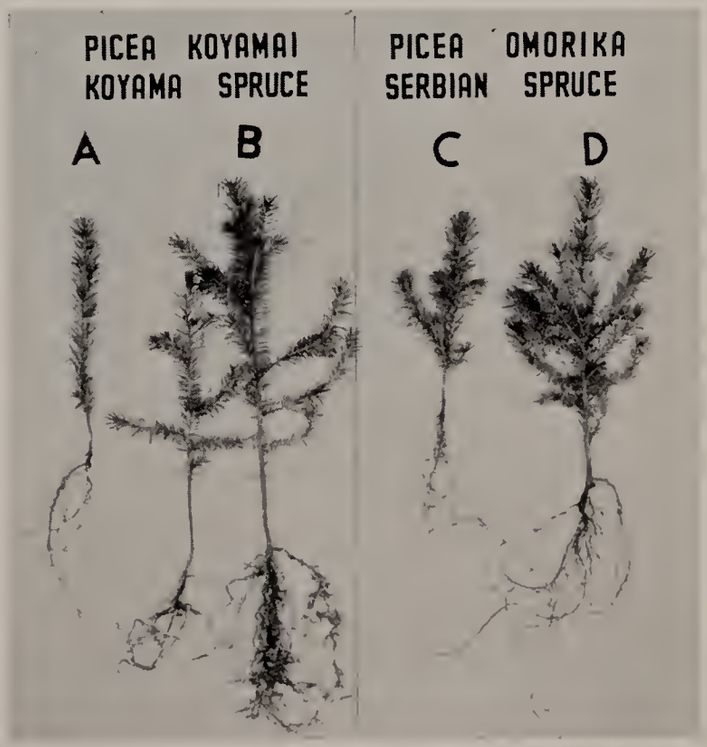



Fig. 57. Two year seedlings of *Picea koyamai*, A; Two 2-1 transplants under B; *Picea omorika* two year seedlings, C; and 2-1 transplant under D.

namely, Koyama spruce and Serbian spruce grown at the present time are shown in Figure 57, both as 2 year seedlings and 3 year transplants. Both have proved hardy at Geneva, N. Y. to date. One of the most interesting exotics to date is the Balkan pine (*Pinus leucodermis*). The writer is planning on publishing separately on this pine in the near future. It is short-needled, slow growing, dark green in color and native to the high mountains in Yugoslavia and Greece. It shows characteristics to be an excellent ornamental and to be a possibility for Christmas tree production if one desires a slow growing species.

This tree seed study in the nursery of various seed sources from many species and exotic evergreens has been both interesting, educational and profitable for the writer during the last several years. We think that many Christmas tree growers, foresters, and nurserymen have benefited from these findings because of the remarks received from many sources. We only hope that in the next few years more of these findings can be published so as to be of more value to everyone in the horticultural field.

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# Associates' Corner

## The Arboretum and the Arts

The Christmas season is upon us with its festoons of mistletoe and holly. Naturally, the evergreens at the Arboretum come to mind. But, although an Arboretum is primarily interested in living plants, it performs many other functions. Strange and surprising are the calls made on the Staff. They may be highly trained botanists, horticulturists, and bug experts, but believe it or not, they are expected to be artists too.

For instance, the head of a large jewelry firm wanted to create some costume jewelry based on dogwood designs. He appealed to the Arboretum for authenticity and was supplied with colored pictures, sketches, pressed and live specimens and library books.

Members of another firm were working hard on designs of Elm leaves and asked if their sketches were correct only to find they were specializing on a foreign elm when they particularly wanted to represent an American one. Disappointed, they suggested they would appreciate the right data and "please make it artistic." They were accommodated and expressed approval of the artistic element.

The same thing happened in another case with Mistletoe. Incidentally, European Mistletoe is very different from our indigenous eastern variety and the Arboretum prevented what might have proved an embarassing error.

An editor of a large publishing house telephoned to say that one of their artists was trying vainly to obtain an illustration of the flower of a Fig, under the impression that it would be spectacular and showy. It so happens that the flowers of the Fig are almost microscopic and hundreds of tiny blooms are borne inside the flask-shaped structure that later develops into the fruit and never even see the light of day. When this peculiarity was explained to him, he said "in that case our artist had better use a fig leaf."

Speaking of illustrators, many publishing houses send their artists to the Arboretum to sketch. They generally come on week-ends and are furnished with marked maps of the grounds so that they can find the desired material.

Nurseries also make use of the two thousand colored slides from the slide library for illustrating their catalogues and art schools borrow them

for lectures.

If you should want to pass a snowy evening by your own fireside, these slides may be borrowed by members. Students working on designs from Nature also avail themselves of this feature of the Arboretum's facilities.

These activities are by no means confined to local talent. An artist in Los Angeles was doing a book on American shrubs and needed species which cannot be found in the West to complete his records. His request was filled in 48 hours. That is how alert our Staff is.

The Director of an Arboretum in Spokane, Washington was featuring a two weeks exhibit of Ginkgo trees as living fossils, but could not obtain any fruiting material there. Specimens were promptly shipped by airmail. A friendly gesture between Arboretums 3000 miles apart, which makes me feel better about the awful smell we endure each Fall. These are just a few of the demands made upon our ever-willing and gifted Staff besides their own plenteous duties. Perhaps their close association with the beauties and marvels of Nature give them a more intense appreciation of all Art. At any rate, they respond one hundred percent.

When you get that lovely costume jewelry for Christmas or enjoy the pictures in that gift book may it bring up happy associations with our beautiful Arboretum. Christmas Greetings!

Marion W. Rivinus

# Arboretum Activities

(*Continued from Page 54*)

exhibition to be held at Rotterdam from March 25 to September 25, 1960. For this show, which will be known as Floriade, it was decided that the botanical gardens and arboretums of this country should prepare an exhibit of their work. To Dr. Clarence E. Godshalk, Director of the Morton Arboretum at Lisle, Illinois, was assigned the task of assembling and preparing for shipment the exhibit materials submitted by the various institutions throughout the country.

In accordance with the directives adopted at Rochester, we have submitted the following materials for display at Rotterdam:

Kodachrome transparencies (suitable for enlargement) of the Arboretum.

Glossy prints of the Arboretum, showing several characteristic scenes.

A set of the Arboretum's publications, including the last five volumes of this Bulletin.

Data of an edaphic and climatological nature, e.g., geological formations and soil types within the Arboretum, extremes of temperature, length of growing season, average rainfall, etc.

It is hoped that, when finally assembled for exhibit at Rotterdam, these items, along with similar ones from other institutions, will present a comprehensive picture of the character and activities of American botanical gardens and arboretums.

## Conifer Nursery

Many years ago a nursery for the propagation of conifers was established in a low-lying area below the greenhouses. For a variety of reasons most of these plants were allowed to develop beyond the stage where they could be readily lifted and moved. The result has been a veritable jungle of overgrown spruces, firs, arbor-vitaes, hemlocks and Japanese cypresses. In all but a few cases these conifers were so badly crowded and distorted that they were unfit for transplanting, even had they not been too overgrown for us to move.

This situation obviously called for drastic action and this autumn we have tackled it in earnest. A few fine, large specimens were given to Longwood Gardens, which possesses the equipment to lift and transport them. A few others were moved to new locations in the Arboretum. Most of what remained were then "rogued out" by a bulldozer and destroyed.

The result is an attractive grouping of a few carefully selected conifers and boxwoods, each with adequate space for development into well formed specimens. Into this area it is our intention to move our Medicinal Garden, utilizing the evergreens as background subjects against which our growing collection of the world's important drug plants can be effectively displayed.

J. M. F., Jr.

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Yedo and Peking. A Journey to the Capitals of Japan and China. R. Fortune. London. 1863.

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* Gift of the Author
** Gift of Mr. Joseph K. Skilling
*** Gift of Mrs. E. R. Kolupaev
**** Gift of Mr. Wharton Sinkler

# Evaluation of a Small Apparatus for Heat Treating Soil

Patricia Allison

Did you ever think of a plant propagator as a practicing plant pathologist? Probably not. Neither have the plant propagators. But when they increase plants by cuttings, that is exactly what propagators must be, for their very starting material is at death's door. The condition of the cutting is not unlike that of the branch that has been girdled by borers or the tree that has been seriously wounded by a lawn mower or a shrub whose roots have been rotted away by fungi. These little would-be trees or shrubs in the propagator's hands have suffered complete amputation of their root systems, without which they would surely die unless given prompt help. The propagator-pathologist provides this "therapy" in three ways. First, the water-supplying characteristic of root systems is supplanted by other means. Water can be supplied through the foliage by syringing or mist systems, and the need for large amounts of new water is curtailed by keeping the moisture content of both air and medium high, thus preventing evaporative losses from the foliage. Second, the propagator-pathologist arranges for the early formation of an entirely new root system by keeping the stub moist, and even by furnishing it with chemicals that act like the hormones occurring naturally in the plants. Third, the propagator-pathologist protects the amputation wound and new roots from fungi, bacteria, insects, mites, and nematodes. This protection must be given not only to the cutting in the bench, but also to the young "recovered" plant after removal to soil in pots. The best method, as always, is to use a pest-free medium and keep it pest-free.

## Obtaining a Pest-Free Medium

Obtaining a pest-free rooting medium is not particularly difficult because mineral nutrition during that phase of healing is not nearly so limiting as water deficiency. Thus soil and compost can be omitted. Obtaining good, rich potting medium devoid of pests, however, is difficult indeed, and one must usually try to reduce the pest populations in an otherwise satisfactory soil rather than hope to find ingredients that are absolutely clean.

Both chemicals and heat are in common use. Chemicals have the disadvantage of expense, limited action against a variety of pests, toxicity to various plants, and toxicity to various propagators. The advantages of heat treatment heavily outweigh those of chemical treatment, but there are definite disadvantages as well. Too much "dry heat" can incinerate organic matter in the soil, and yet soil not far from the heat source remains too cool. Too much "wet heat," such as supplied by steam under pressure, can cause harmful changes in soil structure and mineral content. Too little heat of either type can fail to do the job, resulting in pockets of infested soil from which pathogens can grow into the clean soil. The problem, then is an engineering one, and the goal has usually been to heat all the soil particles to approximately 180°F and maintain the temperature for at least 30 minutes. The trick is in uniform heating.

When dry heat is used, the disadvantage of incineration and poor heat transfer can be lessened only by special equipment in which the soil moves past the source of heat.

Steam is the more efficient soil heater. Not only are microorganisms easily killed by it, but it penetrates soil well and has an enormous heating capacity. Furthermore, when flowing steam, rather than steam under pressure, is used, the danger of overheating is reduced. The maximum temperature the soil can reach is 212°F. If the equipment is properly designed, either bulk or moving soil can be treated with steam, although the former is preferred.

Several types of very efficient soil "sterilizers" have been developed for the nursery trade. These require a rather high capital outlay, and most are of extremely large capacity. Among the smaller units on the market are poor designs that merely represent waste of money and danger to personnel.

Should an institution like the Arboretum, then, simply plan to lose a portion of the cuttings taken and take more to make up for losses? Considering the premium on bench space and the rarity of some of the plant material propagated, let alone the danger of infesting otherwise healthy material, the answer is obviously, "No."

As a part of the current program of improving the green house facilities, begun in 1957 with the reroofing of the Fernery, a search for a relatively efficient, medium-capacity apparatus began. A Dillon Soil Pasteurizer was selected for trial and has been purchased.

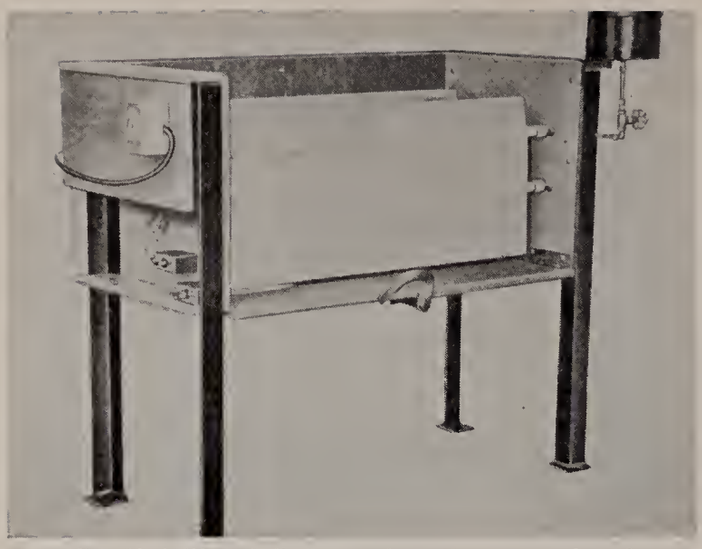


Fig. 58. Dillon Soil Pasteurizer. Front panel and controls cover removed.

## Equipment Description

This instrument, with a capacity of one-fourth a cubic yard (approximately 400 four-inch pots), consists of a marine plywood box supported on steel legs. The lid is removed for loading, and the bottom opens for unloading. Within the box are two vertical heating plates that have steam openings along the mid-line. These plates are visible in the cut-away view in Figure 58. A small water tank is another important part of the apparatus.

The unique heating plates are the most important component of the instrument. They are electrically heated, but are under thermostatic control. This control mechanism does not simply turn the heaters on and off, but also activates a solenoid valve in the water line that allows water to flow into the heaters. The periodic addition of water to the hot plates reduces the critical disadvantages of equipment with conventional dry heating elements buried in a stationary mass of soil, namely the overheating (400-500°F) of soil next to the plates, the drying out of that soil, and hence the reduction in heat distribution from the plates. The entire operation in the Dillon Pasteurizer is timed, and the final power cut-off occurs upon a signal from a thermostat located at the coldest part of the bin.

## Results of Trials

It was known that the potting soil was contaminated with fungi that kill seeds and seedlings, thus the first trials involved simply the comparison of the number of surviving healthy seedlings in soil that had been heat-treated with the number surviving in soil from the same batch that had not been treated. The plants were cucumber and garden peas. Fifty seeds of each were planted in each of three trials. Final data were taken three weeks after each planting.

On the average, 58 per cent of the peas planted survived in heated soil, but only 8 per cent survived in the unheated soil. Cucumbers were more resistant to the fungi. Eighty-five per cent survived in the pasteurized soil; 69 per cent, in the untreated soil.

Because counts and observations were made weekly, there was a fine opportunity to evaluate another of the advantages of using heat-treated soil—weed control. Each week all weed seedlings were removed and counted. From the 45 pots of treated soil involved in the three trials, a total of 17 weeds were removed. Three hundred fifty-four were removed from the non-pasteurized soil! Furthermore, the amount of algal growth on the soil surface was consistently less in the treated soil.

Another evaluation assessed the fungicidal effect of the treatment directly. A plant-pathogenic fungus, *Sclerotium Rolfsii* (the "mustard seed" fungus), was cultured in the laboratory. This fungus forms small, hard, brown bodies (sclerotia) that can survive for extended periods in soil. Both young and old sclerotia from cultures were used in the trials. These were wrapped in packets of 10 each in cloth and buried in various locations in the soil contained in the apparatus. After the heating cycle the packets were recovered. Sclerotia that had not been buried were placed on fresh culture medium; then the packets recovered from the soil were opened and their contents similarly planted. All ten of the twelve-week-old sclerotia that had not undergone heat treatment formed white, fluffy colonies. The same was true for the two-week-old sclerotia that had not been buried. But of the 80 sclerotia recovered from the soil in the pasteurizer not one survived. Two of the culture plates

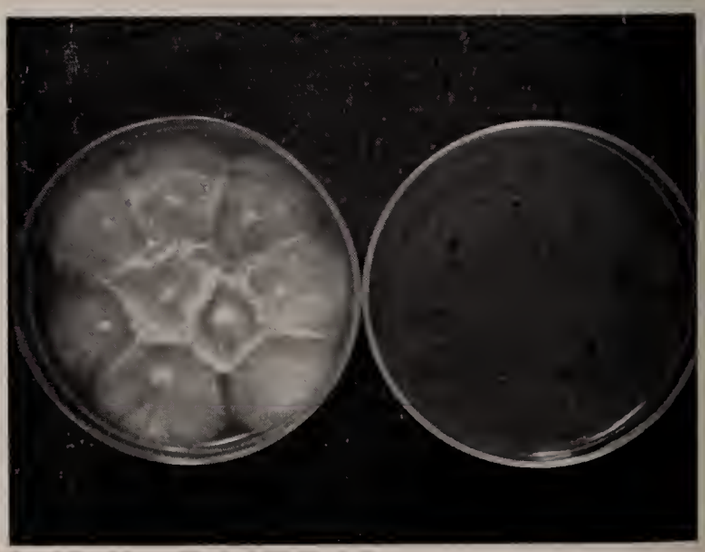


Fig. 59. Cultures of *Sclerotium Rolfsii*. Left: colonies from unheated sclerotia. Right: sclerotia killed during burial in soil heated in Dillon Pasteurizer.

are pictured in Figure 59, one with fungus colonies, the other without.

We are satisfied that the equipment will be very helpful in the greenhouses, not only in improving the propagation regime itself but also in reducing the weed control labor. Meantime, researchers in England and California are investigating the advantages of mixing air with flowing steam. When the mixture is carefully controlled, soil can be heated both rapidly and uniformly to temperatures below 212°F. Early experimentation has revealed that adequate control of certain fungus pathogens can be obtained at temperatures much lower than 180° F. In time, equipment plans should be available that incorporate more of the fruits of this research.

# Book Review

The Garden Flowers of China. By Hui-Lin Li. Ronald Press Company, New York, $6.50. 1959.

Many years ago E. H. Wilson, the indefatigable explorer and plant hunter, labeled China the "Mother of Gardens." That this epithet was well deserved is made abundantly clear in the present volume.

In a work replete with scholarship and sensitive perception, Dr. Li traces the origins of the most important and best loved Chinese plants which for centuries have adorned the gardens of the Orient and in more recent times have found an honored place in Western horticulture.

The author admits that the beauty of Chinese flowers is increasingly appreciated in the West, but goes on to point out that perhaps we fail to comprehend their distinctive symbolism. According to him, the favorite flowers of China are the peony, apricot, Cymbidium orchid, chrysanthemum, and lotus. These, and many other flowers are valued not alone for their intrinsic beauty, but because they symbolize various aspects of character and refinements of culture.

Following a brief review of Chinese horticultural literature, Dr. Li devotes separate chapters to the tree peony, the herbaceous peony, the chrysanthemum, the Japanese apricot (which is actually a native of China), the peach blossom, the sacred lotus and orchids. In all of these accounts the author embodies a wealth of historical and botanical information and emphasizes the symbolic significance of the plants treated.

Subsequent sections deal with such familiar and favorite forms as camellias, roses, lilies and day lilies, crab apples, magnolias, cherries, azaleas, lilacs, wisterias and many more.

In a chapter on exotic flowers the author traces the introduction into China from the West of such plants as pomegrante, oleander and crocus.

Finally he pays tribute to the many collectors from Armand David (the discoverer of the Dove Tree) down through Wilson, Purdom and Meyers. These are the men who, by their pioneering spirit and insatiable curiosity, have so vastly enriched the gardens of Europe and North America.

Among the features which enhance the value of this book are a table of Chinese dynasties, a bibliography of older Chinese works, and an index to Chinese plant names.

The volume is adorned with fifty line drawings (most of them copies of Chinese originals) and a number of carefully chosen and beautifully reproduced plates.

One closes the cover of this work with an increased awareness of the inestimable contribution which the floral treasures of China have made to the gardens of the West.

J. M. F., Jr.

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